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REPORT ON THE SAINT JOHN HARBOUR ENVIRONS

(PROCEEDINGS OF A WORKSHOP HELD ON FEBRUARY 25

AND 26, 1981, AT THE UNIVERSITY OF

NEW BRUNSWICK, SAINT JOHN, NEW BRUNSWICK)

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ENVIRONMENTAL PROTECTION SERVICE REPORT SERIES

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REPORT ON THE SAINT JOHN HARBOUR ENVIRONS

(Proceedings of a Workshop held on February 25 and 26, 1981, at the
University of New Brunswick, Saint John, New Brunswick)

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Environment Canada
Dartmouth, Nova Scotia

March, 1983

Abrégé

La ville de Saint-Jean (N.-B.), port industriel sur la baie de Fundy, a fait récemment l'objet d'une controverse avec les pêcheurs de l'endroit. On affirme qu'il y a une diminution des ressources et de l'étendue de l'habitat marin, mais on ne s'entend pas sur l'origine du phénomène: dans quelle mesure est-il naturel ou découle-t-il des activités humaines?

Si on veut déterminer et résoudre les problèmes environnementaux, la première étape consiste à réunir les divers paliers gouvernementaux, les scientifiques et les nombreux usagers du port et de ses environs. Dans cette optique, on a constitué un atelier dans le cadre duquel les discussions ont porté notamment sur des sujets comme l'histoire de l'aménagement du port, la connaissance qu'on a de l'environnement local et les ressources halieutiques. On s'est servi ensuite de ces données pour étudier les facteurs dont l'influence était évidente et pour proposer des correctifs.

Rien ne permet d'établir un lien entre le développement du port et de ses environs et les fluctuations des ressources halieutiques. Cependant, on a tout lieu de croire que si cette expansion se poursuit, elle entraînera une détérioration encore plus grande de la qualité du milieu aquatique. On a convenu qu'il serait avantageux de constituer un organisme de consultation ou de réglementation qui verrait à examiner systématiquement la mise en valeur et la protection des ressources aquatiques.

ABSTRACT

Saint John, New Brunswick, Canada, is an industrialized port on the Bay of Fundy, which has been the centre of recent controversy with the fishing community. There are claims of declining resources and a loss of vital fish habitat; however, no consensus exists as to what degree the probable causes are man's activities or those of nature.

In an attempt to identify and seek resolution of the environmental concerns, the first step is to bring together the various levels of government, the scientific community, and the many users of the harbour and environs. A workshop was used as the stage and discussions focussed on such topics as the history of development within the port, as well as the knowledge of the local environment and the fisheries resource. This information was then used to discuss what impacts were evident and to suggest remedial measures.

No concrete evidence exists to link historic development in and around the port with fisheries resource fluctuations. However it is reasonable to believe that continued development of this Port and environ will result in a further decrease of its marine environmental quality. The consensus was that some consultative or regulatory authority could beneficially be formed which would result in the organized scrutiny of development and the protection of marine resources.

ACKNOWLEDGEMENTS

We wish to thank the University of New Brunswick (in particular Dr. Martin Thomas), the Department of Fisheries and Oceans, and others, in assisting in the organizing of this workshop and the chairing or participation in the sessions.

We wish to acknowledge, with special appreciation, the work of Mrs. Susan Mahon in bringing order out of chaos, and to Dr. K.L. Tay in managing Mrs. S. Mahon's contract.

Thanks also to Ms. R. McCullum for typing the transcripts of the session tapes and Mrs. B. Pellerin for her patient and accurate typing of the edited script.

PREFACE

Of late, there has been much concern raised with regard to declines in the fisheries resource and the loss of fish habitat in the Saint John Harbour environs. The magnitude of these declines and the amount of fish habitat which has been affected have not been well defined. As well, there has not been any consensus on probable causes from either man's activities or those of nature. The object of this workshop is to review the status of the environment in the Saint John Harbour environs. From this review, the intent is to identify the environmental concerns which may be present; to determine the relative significance of those concerns; to determine their cause, and if possible, to develop a framework for the resolution of the environmental concerns identified. Of importance for this workshop is the need to identify and to seek to resolve environmental concerns. In so doing, the intent of the workshop is not to incriminate but to seek the advice and assistance of all concerned.

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INTRODUCTION

The importance of this topic is related to the economic importance of the Port of Saint John over the last two centuries, and the importance, intensity, and complex nature of the geographical and biological features of the area caused by the outflow of the two rivers and the enormous Fundy tides. It is appropriate that the meeting be on the Saint John Campus because of the University's own active and rapidly growing Marine Biology Program.

Ian Cameron

Dean of Faculty, University of New Brunswick

Saint John, New Brunswick, E2L 4L5

1. PRESENTED PAPERS

SESSION I: Growth and Development of the Port of Saint John

George Lindsay - Session Chairman

Introduction

The first task in pursuing the status of the environment in the Saint John area is to provide an understanding of the development which has occurred in the region over time. For the purposes of the discussions, the area of interest includes Red Head to the east of the harbour, the harbour area itself, and Point Lepreau to the west. These discussions are intended to describe the municipal and industrial developments which have occurred in relation to their impact on the environment. Thus, the session describes the development of the City of Saint John, follows the development of municipal sewage collection and treatment facilities, and describes the present status of sewage discharges.

The Saint John area contains a diverse cross-section of heavy industry including pulp and paper mills, an oil refinery, a sugar refinery, thermal power plants - both fossil fuel and nuclear powered - and a ship building facility. What is attempted in this session is to establish the progress of, and review the current status of, pollution abatement in this industrial sector.

Other factors which can influence the environment of the Saint John area are the physical changes to the harbour. These can range from physical changes to the shoreline, as a result of the construction of wharves, piers or terminals, to the changes in water depths and flow channels. Physical changes combined with the release of pollutants can lead to pronounced changes in the receiving environment. Session I attempts to review these kinds of stresses on the Saint John environs.

1.1 The City of Saint John

Craig Campbell

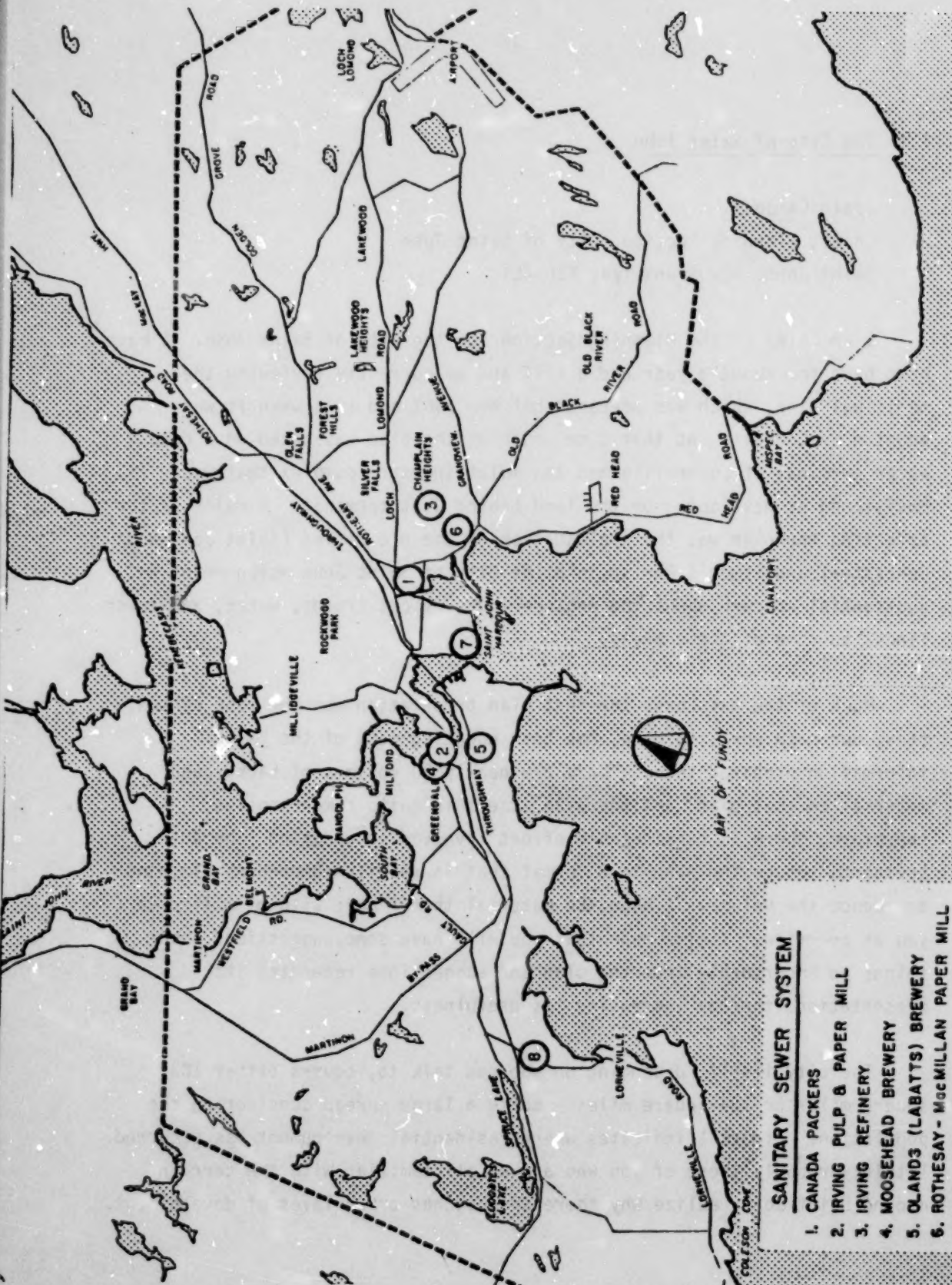
Chief, Planning Section, City of Saint John

Saint John, New Brunswick, E2L 4L1

I am Chief of the Planning Section for the City of Saint John. I have been here for about a year and a half and am currently reviewing the municipal plan, which was prepared between 1967 and 1973 when it was adopted by Council. At that time, much of the plan was based on a deep water terminal at Lorneville and the multi-industry complex that was envisioned as developing on the land behind that terminal. A major factor affecting the plan was the amalgamation of the old cities (Saint John and Lancaster) and Simon's Parish into the City of Saint John which meant a substantial concern about the engineering services (roads, water, and sewer lines) to some of these areas.

Much of the data base for that plan preparation was the 1966 census; thus, our main work, to date, has been updating most of the base information prepared then. There are nearly 20 volumes of background material on that plan, and the plan itself is quite comprehensive; therefore, there is considerable effort involved in updating. We are trying to reduce the plan to a format that is readily comprehensible, and to reduce the volume. I hope the material that I have with me will give you an overview. I also hope that you will have some suggestions about things to incorporate into the plan and suggestions regarding its presentation, thereby increasing its usefulness.

The city itself, depending on who you talk to, covers either 103 square miles or 124 square miles - quite a large spread considering the population. Figure 1 indicates where residential development has occurred. I think probably those of you who are at all familiar with the terrain around Saint John realize why there are patches or enclaves of development.



SANITARY SEWER SYSTEM

1. CANADA PACKERS
2. IRVING PULP & PAPER MILL
3. IRVING REFINERY
4. MOOSEHEAD BREWERY
5. OLAND'S (LABATT'S) BREWERY
6. ROTHERY - MACMILLAN PAPER MILL
7. SUGAR REFINERY
8. SPRUCE LAKE INDUSTRIAL PARK

Fig. 1 - The city of Saint John; Map 1.

The physical features dictate this. These enclaves have been further restrained by the provision of water and sewer services for much of the area. Most growth has been in the suburban areas like Millidgeville, the area on the west side, and the eastern area which has had by far the most new development. There is also some development in what we are calling the more rural areas of the city, such as Lorneville, the area near the airport, and along Golden Grove Road.

The city has been working with CMHC to renew some of the older parts of the city. They have provided funds through the NIP Program and the RRAP Program for rehabilitation of units. Where homeowners are eligible for the RRAP Program, low interest loans (or forgivable loans) are available for rehabilitation to bring those buildings up to an acceptable standard. To date, CMHC has provided more than 6 million dollars for the program, and it is estimated that homeowners, independent of the program, have probably put in at least that amount. Thus, there is an effort to renew and increase the desirability of some inner city areas.

In order to better understand the residential situation, an assessment has been carried out of dwelling units, built over the last 15 years - trying to relate this assessment to census housing and population information. The major development during that period took place in the eastern suburban area, although a fair number of units were built in the northern and western suburban areas.

Many projections made about population growth have been relatively "straight-line" projections from the 1971 and 1976 censuses. One of our aims was to study the merit of using "straight-line" projections for future populations. This "straight-line" approach seems to be unsubstantiated, but we have yet to apply a more refined method for determining what the projections should be. We have, however, been working with CMHC on some short range projections of housing construction and with consultants employed by the school board to study the growth rate and future of the city schools, mainly the high schools.

In 1967, in the initial work done for the municipal plan, the population of Saint John was envisaged as reaching about 130,000 people by 1986. Following that study, a regional impact study was done which incorporated projections regarding the Lorneville area. The projections indicated that if the proposed Lorneville industrial complex was fully developed, the population of Saint John could exceed a quarter of a million people. Naturally, a municipal plan done on that basis may include factors that would be inappropriate to the Saint John of today. However, we are retaining some aspects of the current plan as a contingency plan in case of some major development. One of our major aims within our current planning work is to look at a Saint John with a population of between 80 and 100 thousand, and see what that means to us in terms of policy during the next 5 to 10 years.

The province of New Brunswick, using the 1971 and 1976 censuses, made some projections about population. They studied the city's population decline from about 89 thousand to 85 thousand in the 1971-76 period, and did a fairly "straight-line" projection indicating that by 1991, the population of the city would probably be down to about 76 thousand. However, between 1971 and 1976, the metropolitan area, which extends to and includes Westfield and Hampton, went from a population of 107 thousand to 112 thousand. The projection for this area for 1991 is about 135 thousand. Those figures reflect events of the last few years. Most of the housing starts have been in Fairvale, Quispamsis, Rothesay area, some in Hampton, some west of the city, while very few housing starts in the last few years have been recorded in the city itself. During the mid 1970's, there were numerous units built in the city, in response to development pressures and major construction projects, including Coleson Cove, Point LePreau, and the new regional hospital. There were a number of apartment buildings built, and for a time there was a high vacancy rate. It appears now that the vacancy rate is normal in Saint John and there may be some pressures for further housing developments within the city itself.

One of the major reasons, of course, for the increased number of people living outside Saint John has been the Saint John throughway. The throughway has enabled people to live in Quispamsis and get to work more quickly than if they lived in the Loch Lomond area of the city, or some other areas within the city that have either traffic congestion or are far from the workplace. As well, a major desire of people, it appears, is to escape from the local climate, particularly the summer fog, and also some of the pollution that they associate with the city. Thus, they can go up the river a short way to areas which at one time were mainly cottage developments, establish a year-round home, have more sunshine, and still be able to get to work in a reasonable period of time. Senior government grants have enabled the outlying villages to provide sewer lines and treatment facilities for most of their developments.

Originally, it was predicted that the throughway would facilitate industrial and other developments within the city. However, the idea backfired in terms of residential development within the city itself, since the throughway encourages people to leave. We are now looking at several programs to encourage people to locate within the city. The city is quite large and has several areas which offer attractive residential lifestyles. City policies, to date, have discouraged typical residential subdivision development in the outer areas of the city but these policies are being re-examined.

A topic relating to residential development is that of sewer construction. Figure 2 shows the sewage drainage areas and sewage treatment facilities in Saint John. Since 1970, there have been a number of fairly ambitious sewer construction projects. However, projects in several areas originally scheduled for the next 5 years are being rescheduled because the federal government has discontinued its contribution to the Community Services Program, one of the major sources of funding for construction of major sewer and water facilities within the city. Other projects included in the plan but not yet incorporated in the

Fig. 2 - The city of Saint John; Map 2.

5 year program, include the construction of major interceptor systems for all the old sections of the city. These systems would collect the sewage which now empties into the harbour area. I think these are the main concerns regarding the local harbour environment, and as I point out, there is currently no projection in any 5 year program to deal with them. We will be looking at this concern in the plan review. (However, when new developments occur, such as Market Square, a portion of the collector system will be installed.)

The port and industrial development component of our plan is in a rough draft form. Areas zoned for industrial use represent a fair portion of the developable land in Saint John itself - approximately 12,000 acres. Of that, the Lorneville area and Spruce Lake Industrial Park represent around 6,000 acres, and of the remainder about half is fairly intensely developed; the other half can be developed further. Approximately half of this acreage is controlled by the various Irving interests. The major industries include Irving Pulp and Paper, the Atlantic Sugar Refinery, Saint John Shipbuilding and Dry Dock, MacMillan-Rothesay Pulp and Paper, the Courtenay Bay Power Station, the Irving Oil Refinery, Grandview Industrial Park, McAllister Industrial Park, not to mention the port development around the harbour.*

* A draft background report on the Sanitary Sewer System, December, 1982, has been prepared by the Planning Department (it includes some data on industrial wastes).

QUESTIONS

Dave Wildish: What percentage of the sewage flowing into the harbour is treated?

Craig Campbell: I could not say, precisely; but, not much. The major treatment areas are at Hazen Creek and Lancaster. There are a few smaller treatment facilities in some of the subdivisions. It is not my area of specialty. I had hoped to have members of the engineering department here to speak more specifically on this topic, but due to the strike they are needed elsewhere.

Dave Wildish: Is it something like 50% to be treated or 30%?

Craig Campbell: I could not put a certain figure on that. Construction of new treatment areas, depending on financing, should start soon. This construction will collect sewage from all the areas in Millidgeville, one of the major concerns. Most of the older city systems will then follow.

1.2 Port Facilities

Garnet Phinney

Port Engineer, National Harbours Board

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I am the Port Engineer in Saint John for the Harbours Board. I must say I am pleased to be here with such a learned group. I don't know how many industrialists are here, but I am one of the bad guys who pollute the harbour and also do a lot of dredging. My main areas of responsibility are construction in the harbour, maintenance of the harbour facilities, and fire, safety and pollution control in the harbour. I have with me Ed Vye, my Assistant Engineer; Paul Gilbride, Projects Engineer in charge of all the capital construction in the harbour; Stephen McCavoor, who supervises most of the dredging in the harbour; and Don McGowan, Fire, Safety, and Pollution Control Officer. The National Harbours Board in Saint John is concerned; this is demonstrated by our presence here today. I am uncertain whether this meeting could have happened ten years ago, but certainly it can happen now. We have been meeting with different groups and are starting to work very closely with Environment Canada and the City of Saint John. We are all certainly interested in our environment.

Today, I will briefly trace the history of port construction from 1900 to the present, and then look into the future. I am very interested in Craig Campbell's account of the city and how it meshes with our activities. I may oversimplify, but I do not intend to draw any conclusions about the effects of development in the harbour. That is what we hope to learn here in the next two days.

The harbour that existed at the turn of the century consisted mostly of small piers. Old photographs show that they were mainly pile type structures with finger piers jutting into the harbour. Some of the wharf

construction was of timber crib filled with rocks. There were many wharves along what is called the Straight Shore and along Riverview Drive. These were all commercial fishing wharves extending mostly down the main part of the city at Pugsley and Old East Point. As we started changing the configurations of the wharves in the harbour, the patterns of currents and siltation also changed. Navy Island was indeed an island at that time, although it is certainly not now. All of Courtenay Bay was a mud flat. Some of the older residents of the city told me how a number of years ago they could walk from the foot of Broad Street across the area of the dry dock.

During 1923, the Courtenay Bay channel was created off the main channel as a large turning basin. The dry dock was constructed along with one stage of the Courtenay Bay breakwater. There was other minor construction in the area in 1923. Piers 11, 12, 13 and 14 were developed, and some of the wharf construction was changed in the older section. The old marine dock, which was a solid face wharf, acted almost like a groin extending out into the water.

During the period from 1931 to about 1945, some fairly significant changes occurred in the harbour. The Navy Island Complex and Piers 1, 2 and 3 were created. A coffer dam was built around the area, all of the complex was built in the dry, and then the dam was removed. At that time the dam was alleged to be the largest coffer dam in the British Empire. Quite a feat, and we actually have movies of it being constructed. Again, this changed the harbour. The wharves were mostly the solid face arch type as opposed to the earlier pile type. It was during this period of development that the channel started to become restricted. As well, there was filling along east Saint John in connection with the dry dock. During 1945 two berths were created, the Burma Wharf and the Broad Street Wharf, for the handling of war munitions and supplies. At this time the main channel was realigned. Prior to this time very little dredging was done.

Around 1947 the first big phase called Pugsley A and B was completed. In 1953 the Pugsley Terminal and Piers 2 and 3 were completed. The type of construction was called floating crib, whereby solid face cribs were sunk and backfilled. This type of construction tends to cut down the flow by constricting the harbour and I believe it increased the bed velocity which moves the silt and keeps it in suspension along the harbour. Shortly after, two very significant changes occurred in the harbour; the construction of the Courtenay Bay Causeway in the early 60's, and the final closing of the Harvey John, also called the Negro Point breakwater. Incidentally, that breakwater was partially built as early as 1874-75.

One of the most important constructions in the harbour, during my time here since 1959, was the completion of Rodney Terminal. Rodney Terminal was constructed using prestressed piles. The intent was to construct a marginal wharf with smooth facing so as to not restrict flow. In 1979-80 the wharf was extended 92 metres (300 feet) between Pugsley and the Sugar Refinery. The pilots report that by doing this, different currents have been created in the harbour. As we change the face of the harbour, we change the regime within the harbour, and certain things happen. I am not sure exactly what, but we can notice it in the increased siltation over the years. We log our dredging by berth and are becoming more interested in this. Now we measure siltation every month at different locations in the harbour.

Now that you are up to date, I will quickly tell you about the future in Saint John. We have commissioned a master plan of the harbour. Many of the views shown in the plan are conceptual only, even some of the economic factors have already changed. Nevertheless, it is a useful planning tool. We had one done in 1970 which we participated in with the city and Port Commission, but I think this is a much better one. A potash terminal is proposed for south of the Imperial Oil tanks and the wharf structure out near the Courtenay Bay Channel. We had hoped to have the tender let in May of this year and construction completed by the end of 1982, with potash

being shipped out by the beginning of 1983. The Potash terminal, a Market Square development, and a closure between long wharf and the bridge pier are now underway. The plan shows a groin or protective breakwater extending out by American Rock. It is very difficult during the spring freshet to bring ships into Courtenay Bay. This groin would deflect the currents. The closure of the area from the ferry terminal to Partridge Island is mentioned in the plan. Again, this would restrict the channel, probably setting up greater flows.

A very ambitious project outlined is the construction of a breakwater out from Red Head and almost connecting with the existing Courtenay Bay breakwater. This would create a huge area of land, probably useful for expansion of the dry dock. The plan also shows a breakwater off Partridge Island to protect the shipping in that area. This could be combined with development in the Shag Rock area by extending the breakwater system to create a general cargo complex. There is also interest in development in the Lorneville and the Musquash Harbour areas. I personally believe there is a great potential here for bulk handling of commodities.

That is a very brief overview of the history of the harbour and a little about the future. I hope as the conference continues I will have the opportunity to tell you just what benefits the port brings to the community.

QUESTIONS

Clarence Spencer: I would like to know, first of all, who owns this harbour?

Garnet Phinney: I'm glad you asked that. Some people think that Mr. Irving owns it, but actually we could be real dictators when it comes to

saying what we wanted to put into the harbour, providing that we complied with our own regulations. Why did you ask that?

Clarence Spencer: The reason was that you mentioned earlier in your talk that you owned a sizable portion of that land and you lease it out to various individuals.

My next question is if you leased the land and somebody infills in that land, who owns it? After the lease runs out, can it be reverted back to what it was, and is it practical to remove fill from the filled in areas? Where are the existing harbour lines, and are projected projects going to violate the harbour lines?

Garnet Phinney: We own all the water lots. If we lease a water lot and you go in and fill it, then make improvements on that land, we do not assess you on that water lot, we assess you on the improvements you have made. At the end of the lease, the land reverts back to us. There are established harbour headlands which are enacted by Order in Council. Any changes to those harbour headlands require a further Order in Council to be effected.

Audience: What was the effect of the fire in 1931 on port development in Saint John Harbour?

Garnet Phinney: In June, 1931, the fire started in the area of Pier 5 and swept the entire west side. Within six months, from June to December, the whole area was reconstructed and the first ship sailed back into the harbour. It was a disaster at the time, but it may have been a blessing in disguise because we got a more modern terminal at that time.

Audience: What year was the breakwater extended out to Partridge Island?

Garnet Phinney: Partridge Island causeway was constructed about 1961 or 62, with completion in 1965.

Audience: How many sewage outfalls do you have in Saint John Harbour?

Garnet Phinney: Should I direct that question to Craig Campbell? We have to count up the main sewage outfalls. I used to say 80% of the sewage from Saint John went straight untreated into the harbour. There were once about 85 sewage outfalls into the Saint John Harbour system. We have collected a lot of these as we developed so that the total number of outfalls is now reduced, although the quantity of sewage was not reduced.

1.3 An Overview of the Environmental Effects of Major Industries

James K.D. Hayden

Chief, Industrial Wastes Section

Pollution Control Branch

Department of Fisheries and the Environment

Centennial Building

Fredericton, New Brunswick

Unfortunately the Pollution Control Branch is not quite as old as the harbour, so our statistics on pollution are limited. Starting around 1950, economic activity in the city was relatively stable. The Irving sulphite mill and sugar refinery had been operating for a few years and had established a baseload of liquid effluents for the harbour of about 200,000 pounds per day. In 1958, industries started to develop and pollution discharges increased. By 1980, however, the levels of plant effluents were only 147,000-150,000 pounds of BOD, despite the increased activity. Comparatively speaking, BOD levels are less than they were 30 years ago. This reduction is attributable to changes in processing, environmental technology, and environmental requirements. There could, however, be a further significant reduction within the existing plants. Some plants are having problems which are in the process of being corrected.

A similar comparison between suspended solids in the 1950's and the 1980's, gives more unfavourable results. Suspended solids were around 10,000 pounds a day in 1950, whereas now they are around 75,000 pounds a day; an increase of nearly 8 times. Again, we have gone through a period of growth. Ten years ago we were discharging more than twice the current amount; thus, improvements have been made.

I have looked at the data on quantities of material dredged each year since 1950 and conclude that apparently the quantity dredged and the economic activity in and around the harbour are correlated. For instance,

the Irving Pulp Mill expanded in 1958 to produce Kraft, and the next year the quantity of material dredged from the harbour rose by a factor of 3. In 1960, Irving Refining began operations, and the next year the quantities of material dredged out increased. I don't think that necessarily points the finger at the industry, but I think the industry acts as a barometer of general activity. Housing starts, population growth and other activities, some of them related to construction of the mills or start-up operations, are all factors to be considered. The quantities being dredged range from 100,000 cubic yards to over 2 million cubic yards per year. With the present discharge of suspended solids from the harbour industries, a rough calculation gives a volume amounting to perhaps 400,000 cubic yards per year. On the other hand, if you take the sediment coming down the Saint John River at just a couple of parts per million, that could amount to half a million cubic yards per year. So there are many factors to the dredging aspect. I think I will leave it at that. I have more statistics and numbers here, but they tend to get lost. If anyone has questions, I will gladly answer them.

QUESTIONS

Len Harriott: Referring to the 1958 expansion of the Irving Mill, you said the next year there was three times the quantity of sediments dredged than before; however, the facts are not directly related. The Irving people brought oil into Courtenay Bay, while the inner portion of the harbour was dredged to 20 feet, the outer portion was only 10 feet deep. The following year, that is in 1958, Public Works Canada entered an agreement with Irving and the outer area was dredged, this had nothing to do with the mill expansion.

Jim Hayden: No, I didn't say that it did. I am just saying that there is a correlation between general economic activity and dredging. The Irving Pulp Mill in 1958 is just one example.

Len Harriott: I'm not saying that some of the effluent from the Irving Mill might not have landed up in Courtenay Bay, but the real increase in dredging took place in 1958 because of the Irving development of bringing tankers into Courtenay Bay.

Dave Scarratt: You have suggested that we could anticipate reduction in BOD and particularly perhaps further reduction in suspended sediment loading. Could you indicate where you are actually looking for these reductions, and how you believe they will be accomplished? Those of us who are concerned with the receiving end would appreciate some indication of how you or industry are proposing to make these further reductions. This will be particularly interesting when we start looking for links between performance and environmental changes in the future.

Jim Hayden: Well, specifically, Irving Pulp embarked on a program about eight years ago of in-plant controls and they have progressed quite well in that program. They are collecting spills, and rerouting them back for processing. This meant money to them, savings in heat and in pulp recovered. That program peaked about 1978 when their discharge of BOD was about 30,000 pounds per day and suspended solids was about 20,000. About that time there were discharge water toxicity problems, but a decision was made that the air quality in Saint John was more important than the discharge water toxicity, so the water pollution program was curtailed in favour of an air pollution program. In 1978, when the in-plant effluent discharge controls peaked and were most efficient, Irving increased production. This we think is the reason that BOD is now three times what it was two years ago, and suspended solids have doubled. We feel that their in-plant control system is overtaxed, and cannot handle the increase in mill production. As soon as the air program is finished, we will return to Irving requesting improvements. They have done better and obviously can do it again. At MacMillan Rothesay there has been a clarifier for eight years. However, despite that clarifier there have been problems with

solids control in the mill, in the wood room, and also in handling sludge that is separated out from the clarifier. Sludge handling equipment has just recently gone into operation at the mill and we haven't had a chance to evaluate it, but I am confident that the MacMillan Rothesay figures will decrease for suspended solids because of the better controls.

Audience: Do you anticipate new industries in the Saint John Harbour area?

Jim Hayden: Certainly.

Audience: Can you give me a few examples of what industries are anticipated?

Jim Hayden: I can't make those predictions.

Andre d'Entremont: Is your department concerned about tanker discharges, accidents (collisions or groundings), or such aspects as cleaning out bunker tanks, etc.?

Jim Hayden: In 1950 little attention was paid to oil spills. They happened, but infrequently. In 1960, with the Irving Refinery operating, there were probably about 1,300 pounds of oil a day entering the harbour. When the refinery expanded, improved treatment facilities were added and the amount of oil leaving it decreased. However, the number of oil spills has increased. Recent data, averaged over the whole year, will give an estimate of 5,000 pounds per day of oil entering the harbour.

Spills are funny things. Firstly, you don't always know how much has been spilled. Our reporting systems are much better now. People are charged and fined for not reporting oil spills so that now we know about more of them. Ten or 20 years ago there may have been just as many oil spills, but we just did not know about them. Secondly, the quantity that is cleaned up after some spills is difficult to determine.

Andre d'Entremont: Does the Irving Refinery have contingency plans of their own in case something does happen?

Jim Hayden: They have all the necessary equipment, tugs, booms, in fact, there is a complete company that is set up under the Irving umbrella for cleanup, and they are experienced at it.

Dave Scarratt: I would like to return to the question of effluent discharges. You have tackled two of the major sources, namely the two pulp mills, but the question that Mr. Campbell was unable to tackle was the actual quality of the effluent leaving through domestic sewers. Obviously there must be a fair amount of industrial discharges, perhaps from some of the smaller industries which might contribute significantly both to BOD and solid discharges. Do you have any measure, at the moment, of the contribution to the harbour waters by the domestic sewerage system in terms of BOD and of solids? Now that the federal government is apparently foregoing its cost sharing arrangement with municipalities, is there any likelihood that the provincial government may become involved?

Jim Hayden: I don't know what the smaller industries are discharging through the municipal system. There are a few relatively larger plants, like Moosehead Brewery and Labatt's Brewery, on which information could be obtained more easily. Many of the smaller industries are processing plants or dairies, etc.

So far, the philosophy has been to let the city handle the industries and look after, through by-laws and this sort of thing, discharges to the sewers; however, the provincial environment can go up the sewer and start dealing with that. Great costs result when you do that for the industries themselves, because the cost of each one putting in some kind of treatment would be quite high - certainly much higher than the common treatment through the municipal system. I am not saying that we leave it entirely to the city because we do look at some of the large contributors. We are

dealing with Moosehead right now, for instance, and we do try to deal with the larger of the industries. Labatt's is already on a treatment system.

1.4 The New Brunswick Power Commission

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I shall cover the development of power generating plants around Saint John in the context of the areas of interest of this workshop. Saint John is the major industrial center in the province. Approximately 20% of the total annual generation of New Brunswick power is sold through either the local utility or directly to the Saint John industrial users. The generation to meet the demand, for understandable reasons, is as near as possible to the requirement; specifically at the Courtenay Bay Station in east Saint John and at the Coleson Cove Station in Lorneville. A generating station is now being constructed at Point Lepreau which, for the purposes of this workshop, we consider to be within the Saint John Harbour region.

Saint John Harbour is used mainly by New Brunswick Power at these generating stations as a water resource for "once-through" condenser cooling and for auxillary cooling within the plants. The Courtenay Bay Station, for example, which is in east Saint John, utilizes approximately 70,000 imperial gallons per minute - drawn and returned to Courtenay Bay through 9 square foot sectionalized pipe which runs under Bayside Drive and out onto the Courtenay Bay breakwater. This water is returned to that same pipe at a temperature of approximately 18 F degrees above the ambient temperature and contains small quantities of defouling chemicals, usually chlorine, and some rust inhibiting chemicals. The rust inhibiting chemicals generally plate out on the system (they are designed to do that) to protect the internals of the system. When this cooling system was

designed and installed in the early 1960's, the design would have been considered state of the art. Today, considerably more attention is paid to the environmental problems of intakes and discharges from power plants. The Coleson Cove Station, which was designed and built in the early 1970's, incorporates a number of design changes or design features which reflect that increasing importance of intake and discharge flows. These are fairly large flows, the Coleson Cove Station for example takes 250,000 imperial gallons per minute from the Bay of Fundy and returns it to the Bay some 25 to 28 F degrees above ambient temperature. We use small quantities of rust inhibiting chemicals in the Courtenay Bay cooling water system; however, we do not use defoulants in that system.

Several features of the Coleson Cove System indicate the kinds of effort now being made. For example, the intake screen velocities are very low, which reflects an increased interest in the problem of fish impingement against these screens. Generally, screens that were designed prior to Coleson Cove had screen velocities of approximately one to two feet per second. The Coleson Cove screens are around two feet per second. Another feature of the Coleson Cove intake-discharge system is the tunnelled or submerged outfall. The water from the condenser and the auxiliary cooling cuts back into the discharge pipe, which runs into a standing well on the shoreline at Coleson Cove. The water is then piped out to sea and discharged below the surface 300 feet offshore. A diffuser cap on the end of the pipe imparts a horizontal flow to the outgoing cooling water. Efforts have been made to orient this cap so that it discharges in a particular direction to better promote mixing and to minimize the impact of the warm water on the surrounding water environment. Studies conducted since that plant became operational indicate that the initial design criteria were easily met. The initial design criteria which were worked out between New Brunswick Power, and the provincial and federal departments of the environment, allowed for no temperature at the surface to be more than 9 F degrees above the ambient temperature, even though the temperature of the water from the outfall itself might be up to 25 degrees above the ambient temperature.

At Point Lepreau we have gone another step. This station requires something like 425,000 imperial gallons per minute of sea water for cooling purposes. The system for withdrawing and returning that water has one of the most advanced environmental designs in Canada, and maybe in North America. The water is taken from the bay subsurface. The submerged intake is on the west side of Point Lepreau. Discharge is submerged on the east side of Point Lepreau. Point Lepreau has a tunnelled intake and outfall. The water is drawn through a submerged 40 foot diameter radial intake structure situated at the end of the intake tunnel, the size of which has been selected to achieve a certain intake velocity. There is a fish bypassing feature, on the riser of the intake tunnel just ahead, to the screens themselves and the pumps. The tunnelled discharge is similar to Coleson Cove discharge, although it is somewhat longer. The intake is approximately 2,100 feet long, while the discharge is approximately 1,500 feet long. The outfall is similar in design to the Coleson Cove outfall. It has a standing riser at the intake end and discharges through a horizontally discharging cap at the end of the discharge tunnel oriented in order to take advantage of the existing currents in the Bay of Fundy in that particular area.

The cooling water aspect is the major but not the only concern that we have in designing and building generation stations. There has been more emphasis, since the 1960's, on the control of oil spills, and the control and treatment of, for example, runoff from coal storage areas, the collection and treatment of regeneration wastes which come from the station's water conditioning plants, and normal plant sewage waste both during and after construction. In the case of regeneration waste, the early stations such as Courtenay Bay did not collect these wastes at all. They simply discharged them after a water conditioning cycle. The more recent stations like Coleson Cove and Point Lepreau are designed to separate and collect these wastes and to treat them in a system on the property. The methods of doing this have improved over the years. At Coleson Cove we initially believed that we might be able to utilize the

natural neutralizing capabilities of the wastes, and to some extent we could, but it did not work as well as we expected because of the length of the regeneration cycles and the difficulties of timing events to happen at the proper times. We have overcome that problem in the more recent plants, like Dalhousie and Point Lepreau, by adding the capability to adjust pH.

Over the years, we have collected significant quantities of field data in and near our generating stations which probably would be of interest. Many of you have seen this data and utilized it. We have effluent monitoring data from Courtenay Bay, Coleson Cove and the Point Lepreau stations, and reports on cooling-water plume dispersion at Coleson Cove. We have baseline reports about Point Lepreau which were part of the environmental impact assessment process. There are also volumes of data on aquatic biology, terrestrial ecology, radiological background, marine chemistry, meteorology, water temperature, tides and currents. As well, we have a series of ten interim reports dealing with specific items such as water supply at Point Lepreau, transmission lines, and the preliminary and final impact of worker housing at the Point Lepreau plant. All these reports are available publicly through the libraries or from New Brunswick Power, or the provincial or federal departments of environment. In addition to this, we have collected a good deal of background data for these reports, including data on sedimentation and bottom conditions at the various sites selected for development of nuclear power plants in New Brunswick.

It would be inappropriate to conclude the discussion without mentioning the impact on air quality of our plants in the Saint John area, even though here we are focusing on water. We recognize that the Courtenay Bay Station contributes to Saint John regional air quality problems, because of its particular location, its age, and the particular stack emission parameters (the height of the chimneys, the velocity from the chimneys). Unfortunately, the remedies available to us at this plant are limited to improving the quality of the fuel being burned. We are

currently undertaking a fuel blending study designed to assess the improvement to air quality, achieved by blending light oil with Bunker C. Hopefully, we can achieve a 30% reduction in fuel-sulphur content which should be reflected in a similar improvement in emissions from the plant. We plan to start testing this in May of this year, in time for the summer problem period. The Coleson Cove Station, on the other hand, we don't believe to be a major contributor to the air quality problems in Saint John. Since it is newer, it has a much higher stack and better dispersement capability. At Coleson Cove, it is also possible to switch from a high sulphur to a lower sulphur fuel. Each decision to make this switch is based on data from air quality and meteorological monitoring systems which have been developed over the years. Since Coleson Cove came on line we have, in fact, only switched fuel at the plant twice for reasons based on data from monitoring. This system of monitoring and switching is known as a supplementary control system and is also employed at our Dalhousie plant in northern New Brunswick.

In conclusion, New Brunswick Power has a considerable interest in the Saint John Harbour environment. We hope to contribute to this discussion in the next day or so, and identify the particular problems and what we might all do about them.

QUESTIONS

Mick Degraeve: Do you anticipate biofouling of the intake tunnels at Point Lepreau?

Jim McGrath: We don't anticipate it, but we have made some provision for it. We have installed (embedded in the tunnel walls of the intake) a series of lines capable of carrying chlorine or some other defoulant to the end of the line and using that for defouling. When we arrived at the

critical stage of deciding whether or not we were going to chlorinate Point Lepreau intake tunnels, we lacked the experience to determine whether mussel fouling or fouling by other organisms might be a problem. We spent a lot of time talking to people like Dave Scarratt at St. Andrews, and to various people at power plants on the eastern seaboard. As well, we incorporated our own experience at Dalhousie and Coleson Cove. We decided that we would not chlorinate the Point Lepreau intakes, and made a commitment to that effect to both the Departments of the Environment with the proviso that if we find ourselves in difficulty with fouling of those intakes, we can return and ask permission to use defoulants. Now we have made provisions in a couple of ways. Firstly, the tunnel diameters are approximately a foot larger than is necessary under normal hydraulic conditions so as to accommodate up to a foot of growth on the inside without affecting the hydraulics. Secondly, we have installed the pipe work on the inside, although we are not intending to keep any equipment on the site. Our recent experience at Coleson Cove indicates that we may well be on the right track. We don't see a big problem at Coleson Cove with fouling.

Mick Degraeve: So if you do chlorinate, it will probably be intermittent?

Jim McGrath: I'm not sure. There is one body of thought that says the intermittent method is the best. If you mean by "intermittent", only during the summer periods, then chlorination is probably completely unnecessary when water temperatures are below a certain critical level or when the animals are not there to attach themselves. A second body of thought suggests that continuous chlorination at a very low level is better than intermittent chlorination at a high level.

Dave Wildish: Can you tell us when the small generating plant at the head of Musquash estuary will close?

Jim McGrath: Sorry, I don't know.

SESSION II: Conditions in the Receiving Environment

Greg Gillis - Session Chairman

Introduction

The first session tends to focus on the changes which have occurred on the landward side. What this session sets out to do is determine what we know about the receiving environment, and to seek out the impacts which can be documented. Considerable discussion focuses on sedimentation in the Saint John Harbour environs. The first question which needs to be answered is whether or not there is an impact from sedimentation. From this, then, the next question to be answered is whether or not the impacts result from natural causes or whether man, in the pursuit of development activities, has been the cause. Over the years, considerable concern has been expressed with regard to harbour dredging and the dumping of dredge spoils. This session outlines our current knowledge of the sedimentation patterns of the harbour.

Other topics considered include information on waterfowl populations, oceanographic conditions, trace metals, macro-infauna investigations, and changes in benthos and bottom types. All these topics are addressed to determine where documented changes have occurred in the receiving environment.

2.1 Aerial Colony and Chemical Pollutant Surveys for Marine Birds in the Saint John Harbour and Approaches

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Aerial Surveys - Between 1969 and 1980, 15 aerial surveys to determine species, numbers and seasonal distributions of waterfowl were flown by the Canadian Wildlife Service along the New Brunswick shoreline of the Bay of Fundy. Summaries of surveys for portions of the bay have been published up to 1973 (Pearse and Smith, 1974), updated (CWS Atlantic, 1979), and in a task report to the "Lorneville Environmental Impact Study" (Baird, Christie and Pearce, 1973, unpublished m.s.). The results of the aerial surveys are biased as they were flown under a variety of weather conditions, the same flight routes were not always followed, and some areas were flown more often than others. Not enough flights were made to determine peak numbers of birds through all seasons, however, the surveys do provide an index to the relative numbers and kinds of birds using various coastal regions.

The counts for the CWS Saint John Harbour block, which extends from Cape Spencer in the east to Seely Point on the Lorneville Peninsula, indicate that it is not a significant area for migrating birds. Winter counts on seven surveys ranged from 14 to 214, excluding over 1,400 gulls. Gulls, although present, were recorded only on two of the surveys. Spring counts on six surveys ranged from nil to 2,210. Migrating Scoter comprised 1,840 of that total. Twenty-two and 163 birds were counted on the two fall surveys. The major over wintering birds were Black duck, Merganser, Goldeneye, Herring gull and Great black-backed gull. During the spring and fall migrations Cormorants, Scoters and Eiders use the area, along with the above species.

Colony Surveys - The only significant breeding colony for marine birds is on Manawagonish Island, where five species of birds nest. Ground counts indicate dramatic increases in Double-crested cormorants and Herring gulls, similar to the increases throughout the Maritimes in the 1970's. The Great blue heron and Great black-backed gull populations have remained stable and Common eider have become recent nesting birds on the island (Table 1). The only other colonies that we have record of were at the Reversing Falls, Goat Island (13+ pairs of Great black-backed gulls) and Middle Island (7 pairs of Herring gulls).

Table 1 - Manawagonish Island colony surveys* (pairs).

Species	Year Surveyed					
	1961	1963	1970	1971	1972	1979
Double-crested Cormorant	45	-	70	200+	100+	2100
Great Blue Heron	-	7+	-	20+	-	27
Herring Gull	200	-	-	-	200	600+
Great Black-backed Gull	45	-	-	-	50	30
Common Eider	-	-	-	-	-	25

*Data from Maritimes Nest Record Scheme.

Contaminants and Birds - Eggs of Double crested cormorants were collected from Manawagonish Island and analyzed in 1972, 1976 and 1980 for organochlorine and mercury residue concentrations as part of a continuing CWS program to attempt to assess the implications of the contamination on the productivity of birds in Atlantic Canada (Pearce, Peakall and Reynolds, 1979). Four other colonies in the Bay of Fundy were also sampled. DDE and

PCB residues decreased significantly between 1972 and 1976. Mercury residues remained about the same in both years. Results of the 1980 analysis are unavailable. Future collection of birds from Manawagonish Island may include analyses of heavy metals, along with the above mentioned pollutants and should be useful for detecting some changes in the marine environment.

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QUESTIONS

Bill Ayer: I am interested in whether other diving bird populations that eat fish are increasing along the Bay of Fundy, as well as the Eiders and Cormorants?

Bruce Johnson: We have no evidence that they are. We can't sort out why a particular species is going up or down with some of the other species because they run the gamut of a great many stresses at wintering grounds south of the border, as well as with hunting, and oil pollution problems, etc. But with the Cormorants, there has just been a phenomenal increase.

Bill Ayer: What is the magnitude of the drop in PCB concentration in eggs surveyed?

Bruce Johnson: The range of 10 eggs in 1972, PCB, parts per million wet weight was 9.13 to 18.7, and the mean is 14.6 ppm. In 1976 there were five eggs analyzed, and the mean was 6.31 ppm. I don't know what the significance is. It is good to see a drop, and the birds apparently are healthy. We don't know or cannot detect what effects some of these pollutants have on birds. It has been demonstrated that DDT has caused egg shell thinning, but apparently the levels of DDT residues now are apparently not a problem.

George Lindsay: Are the mercury levels a particular problem, or were the analyses done just to find out what is present?

Bruce Johnson: Just to find out what is present.

George Lindsay: Are they in the same range as the PCBs?

Bruce Johnson: Mercury levels in 1972 were 0.22 ppm, and in 1976, 0.24 ppm.

Garnett Phinney: Is Manawagonish Cove, off Taylor's Island, a game reserve or one of the designated salt water marshes there?

Bruce Johnson: It is not designated as such.

Dave Scarratt: There was some discussion about 8 to 10 years ago when there were proposals for reclaiming that marsh land area. We were asked to comment on this. I suggested at the time that because marshes are a dwindling resource in the Bay of Fundy, this was an opportunity for the municipality of Saint John to identify and retain the marsh. We heard nothing further, but it would be nice if those sorts of suggestions were acted upon and the city was genuinely intending to preserve some of these marginal habitats. If it is accepted as a hands off area, I think that is terrific.

Bruce Johnson: We constantly encounter these problems. The upper salt marsh has been dyked off for agriculture. Sometimes we are asked the significance to birds of a particular salt marsh. The reply is that it is a unique area. Then, we are asked, "If all the birds nesting there were wiped out, would this make a dent in that particular population?" The disappearance of one marsh is unlikely to decrease the population; however, the loss of many marshes will. I wish there were more natural areas, particularly in close proximity to large cities, that were just set aside. I think we are sometimes very hard pressed to precisely define the significance of an area and say, "Just let it be." We realize that there is great pressure for using the land in other ways, many of which are irreversible.

Val Hawkins: Are you monitoring dioxin levels in your Herring gull eggs or in Cormorants?

Bruce Johnson: No, there were no Herring gull eggs taken there, but there have been Herring gull eggs analyzed elsewhere.

Val Hawkins: Was it Double-crested cormorants?

Bruce Johnson: Yes, that was on Manawagonish.

Val Hawkins: Were dioxins in that list or are there any plans to do dioxins as well as PCBs?

Bruce Johnson: I don't know what the sampling program will be on dioxins. Probably there will be some more sampling in a variety of areas, right across the country. I am not certain if the Canadian Wildlife Service, Health and Welfare, or someone else will actually be doing it.

Dave Scarratt: We were talking a few minutes ago about increases in some of the leading bird populations on Manawagonish. These increases might be partially related to the location of the new dump near Spruce Lake. Is there any evidence that changes in the bird population are linked with changes such as the relocation of spoil sites or changes in urban patterns or agricultural patterns? Can we get any clue from changes in the bird population about what might be happening in the region?

Bruce Johnson: Undoubtedly the increase in gull populations is related to the availability of more food from the dump sites and fish plants. For instance, after a fish plant closes, a particular gull population will leave. In other places where there have been increases in eutrophication in fresh marshes from sewage, there have been increases in bird use of that particular area. It was not planned, but the birds thrive on the fertilizing effects of the wastes.

Dave Scarratt: Is there any reason why the populations of birds like the Double-crested cormorants and the Eider ducks should have suddenly shot up?

Bruce Johnson: Part of it might be better protection. The fishermen dislike Cormorants, as you well know, and they are constantly complaining about Cormorants.

Dave Scarratt: Are there still bounties on any of these birds?

Bruce Johnson: No. They are protected by provincial law.

Mike Dadswell: There is a season on Cormorants, but Cormorants are a migratory bird, are they not?

Bruce Johnson: They are migratory, but they are not "migratory" under our provincial Act. A number of migratory birds were omitted from the Act, and a number that were originally omitted, have been added since 1917.

Bill Ayer: Could primary productivity in that particular area or in the Bay of Fundy have changed such that production of the proper size and species of fish as forage for these birds was affected?

Bruce Johnson: We have not studied that aspect. Our sea bird researcher, Dick Brown, is quite interested in productivity, and its relationship to currents and upwellings. He is studying the feeding areas of seabirds and offshore seabird distribution. A little further down in the Bay of Fundy upwellings attract thousands of birds, thereby affecting the productivity of the area.

Bill Ayer: I am thinking of nutrient transport from the Saint John River into the Bay of Fundy. If one could hypothesize that transport has increased over time, could that in some way be related to increases in piscivorous bird populations?

Bruce Johnson: This is just one of many Maritime areas with increases. I don't know the exact reasons, but probably the main reason is increased protection.

Dave Wildish: I don't think there is enough detailed information available to link trophic levels of any kind.

Bruce Johnson: CWS has not been doing that kind of work in the Bay of Fundy. Dick Brown, however, is looking at highly productive areas as offshore concentration areas for seabirds from Labrador to the Grand Banks. Birds are usually found in areas that are productive for fish.

2.2 Bioaccumulation of Toxic Compounds in Pulp Mill Effluents by Aquatic Organisms in Receiving Water

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The work that I will talk about evolved through the CPAR Program, which was run under the auspices of Environment Canada. It was developed to assist pulp mills to determine their impact on the environment, particularly the aquatic environment. One of my aims was to study the chronic effects of low levels of various pulp mill toxicants. Many studies have been done on acute toxicity, and we are well informed on the ranges of chlorinated phenolics, resin acids, and fatty acids found in effluents. We know what concentrations are lethal to rainbow trout or salmon, but from the viewpoint of a longer term exposure, I was interested in how, and to what level the toxicants are accumulated, and what effects they have on the organisms. The particular project I will refer to is available as a project report (#675) from the CPAR Secretariat, Environment Canada, in Ottawa. The objectives of my study, which consisted of two phases, were: (1) to sample some of the organisms occurring in the Saint John Harbour area and to determine the levels of the various compounds within these organisms, and (2) to examine the individual compounds being taken up by selected organisms under controlled, laboratory conditions. Phase (1) particularly concerns the group here today.

The Irving Pulp Mill is a 750 ton per day bleach Kraft mill. Around the time I started work, its 300 ton per day sulphite mill was shut down. The other mill in the area is MacMillan-Rothesay in the Courtenay Bay area, an 800 ton per day newsprint mill which imports numerous chemicals and produces only groundwood pulp on site. The fate of mill effluents is influenced by complex water movements within, above and below the mills.

Five sites were chosen as sampling stations for collecting biota. One outside the harbour off Manawagonish Island; a second underneath the Harbour Bridge; a third off Boar's Head, which is above the harbour; a fourth off Goat Island; and a fifth in the Milkish Channel, separating Kennebecasis Island from the Kingston Peninsula. At this point I would like to gratefully acknowledge the cooperation of Martin Thomas and his Marine Estuary Research Group at UNB, Saint John, who collected the samples; Peter Silk of RPC, who was responsible for the analytical chemistry; and the staffs of Irving and MacMillan-Rothesay Mills.

In Phase (1), effluents from the two mills were sampled then "finger printed" to identify the relevant chemical compounds. The "finger prints" were then compared with the toxicants to be found in the organisms sampled in and around the harbour area. Samples from the Kraft mill were taken from the combined chlorination and extraction stages during the bleaching process to include the chlorinated toxicants that would be present in the outfall. From the MacMillan-Rothesay mill, the effluent was sampled from the end of the pipe.

Some notable features in chromatograms or traces of part of the effluent received from the Kraft mill during 1977 and 78, are the levels of trichloroveritrole, dichloroveritrole, and tetrachloroveritrole. Veritroles are important since they are chlorinated organics derived from the degradation of lignin, which occurs during the pulping process. More specifically, the veritroles are derived from their corresponding catechols and guaiacols. Also present are some dichlorophenols and trichlorophenols, and some lower degradation products of pentachlorophenols, which were not found in the effluent.

There is a mixture of resin acids, fumaric acid, dehydroabietic and abietic acid in the groundwood mill. The fatty acids are present as a group, plus numerous compounds based on turpene, e.g., dichlorophenol, trichlorophenol, trichloroguaiacol, and tetrachloroguaiacol. Basically,

the lower chlorinated compounds, that is the dichlorophenol and trichlorophenol, occur in higher concentrations. These concentrations in micrograms per gram of oil extracted from the effluent range from 31 up to 422 micrograms, depending on the day of effluent sampling. Similarly, for the trichloroguaiacol, higher concentrations range from about 32 up to about 460 micrograms per gram, again depending upon sampling time. The groundwood mill sample shows methyl dehydroabietate as between 0.45 and 0.68 micrograms per litre of effluent.

A great deal of preliminary work was done before biota could be examined for toxicant uptake. "Blank" tests were run on clean animals, particularly blue mussels (Mytilus edulis) and the soft shell clam (Mya arenaria) from the Shediac Bay area, to check whether or not they contained any of the toxicants under investigation. Then "spiking" experiments were done with known quantities of chlorinated phenols and guaiacols and the resin acids. These experiments were aimed at developing good recovery rates, thereby increasing our confidence that the amounts detected represented amounts accumulated by the organisms. That's where a lot of the tricky chemistry came in!

We tried to sample several different kinds of fish - tomcod, soft shell clam, blue mussel, sand-worm, smelt, winter flounder, hake, and the spiny dog fish from the different sampling areas. Trawling and set gill nets were used where possible. Under the Harbour Bridge at low tide, one could collect what few animals there were by hand, and in the other areas a drag was towed along the bottom. We also collected sediments for analysis using a grab and sediment corer.

A representative chromatogram will show chlorinated phenols, dichlorophenols, trichloroguaiacols, tetrachloroguaiacols and trichlorophenol. These four compounds occurred in a particular clam extract from a sample taken beneath the Harbour Bridge in May, 1977. In addition, there was a tremendous peak identified as pentachlorophenol. The

tomcod and the liver of a flounder collected from the Milkish Channel exhibited the same range of compounds, with pentachlorophenol again present. The presence of pentachlorophenol is important to us because first, it is a parent compound from which the lower chlorinated phenols can be derived, and second, it is strongly implicated in toxicity in its own right. Much work has been done on pentachlorophenol alone. I would like to emphasize that we did not find it in the effluent, but it did appear in the animals examined. We detected some of all the compounds in all the sample organisms collected from the Harbour Bridge and Milkish Channel, as well as from Manawagonish Island (where the spiny dog fish was caught). A wide range of concentrations was detected, but no particular pattern was found: first because there was insufficient data; and second, because the method of sampling did not indicate where these fish had been, i.e., they may have been up and down through the harbour several times. Nevertheless, it is noteworthy that these animals contained the compounds in sublethal concentrations.

We wanted to determine how the compounds were partitioned within particular animals; that is, where they were stored and their fate once they were taken up. For instance, a flounder was collected in the Milkish Channel and divided into portions that consisted of muscle, viscera (the liver excepted), and skin and fat. I was a little puzzled by the fact that we found no dichlorophenol in this particular animal, or in any of the tomcod or smelt that were examined. I expected the presence of dichlorophenol because the animals should be catabolising the pentachlorophenol and trichlorophenol. In the case of the flounder, the liver and fat contained the highest concentrations of trichlorophenol, trichloroguaiacol and tetrachloroguaiacol. In the tomcod, viscera seemed to contain more of the accumulated compounds. The smelt, which included the liver because it was very difficult to separate out, contained most of the compounds as well.

In an extract of the sediments, we found resin acids, dehydroabietic acid, and many of the fatty acids (oleic, stearic, palmitic, and myristic). There were also some PAHs and pyrene, which again were not found in the effluent, but appeared during the sediment analysis. There are probably many other chemicals present, but lack of time, money and people limits their identification. We tried to quantify some of the material in the sediments, and although we found very little in the way of chlorinated compounds, we did find trichloroveritrole and tetrachloroveritrole. This is likely because chlorinated compounds are more soluble in water than chemicals like resin acids and fatty acids. We were not surprised when we found the resin acid and DHA in higher concentrations in the sediments. We found approximately 25 micrograms of DHA per gram of dry weight of sediment under the bridge; at Boar's Head, approximately 13 micrograms per gram; at Manawagonish Island approximately 10 micrograms per gram; and in Milkish Channel (where we had two samples) approximately 7 micrograms per gram. We had a good deal of trouble detecting the resin acids and fatty acids in the animals we examined. The only good samples we got were the clams and tomcod, collected from Boar's Head. We found approximately 3 micrograms of DHA per gram of dry weight in the clam, 1.4 microgram per gram in the muscle of the tomcod, and about 1.5 microgram per gram in the skin. In all the other samples there was massive interference, particularly with the fatty acid analyses. There are numerous fatty acids, not of pulp mill origin that belong to the animal itself, and so it became a real problem to try to separate some of these out, consequently our analyses were not as complete as we had anticipated.

QUESTIONS

Scott McKnight: One question for clarification. Did you analyze the water sediment and suspended particulate matter?

Bev Bacon: We looked at water, but detected nothing. We took water samples right underneath the bridge and then further in the South Bay area, but then it was into May, and we ran into freshet problems. As the flushing rate was high, we did not expect to find anything.

Scott McKnight: What about suspended particulate matter?

Bev Bacon: No, we did not analyze that.

Bill Wilson: You did not find tetrachlorophenol in mill effluents, but you did find it in the organisms. Would you speculate as to the source of pentachlorophenols?

Bev Bacon: It would be just that, speculation, as I don't have the data to back it up, but pentachlorophenol is, as you know, a wood preservative and I know that it is used in the pulping industry to help preserve wood-chip piles. I don't know whether Irving and/or MacMillan-Rothesay use it, but that could be a source. I think that its commercial name is "Dowacide".

2.3 Oceanographic Conditions in the Saint John-Kennebecasis Estuarine Complex

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Introduction

The Saint John-Kennebecasis estuarine complex above the Reversing Falls is a unique system and has attracted wide attention from scientists. The main features of the system are the Saint John River, one of the largest on the eastern seaboard, which constitutes a relatively normal salt wedge estuary above its confluence with Kennebecasis Bay. Kennebecasis Bay, on the other hand, is a fjord-like body of water receiving drainage from two rivers of moderate size, the Kennebecasis and Hammond. Between the confluence of these systems and sea lies a third component, the Saint John gorge culminating in the Reversing Falls rapids. The Reversing Falls and gorge, forming a high sill and mixing basin, respectively, have tremendous influence on the estuarine complex.

The first general scientific study of the system was that of Rogers (1936), although there were earlier specialist studies such as that of Matthew (1894) on the outlets of the Saint John River and Hachey (1935) on tidal mixing. In 1960, Trites conducted an oceanographic and biological survey of Kennebecasis Bay and the Saint John River estuary which presented details of general oceanography. Subsequent studies have all been of a more specialised nature, reflecting the interests of UNB at Saint John, interests of the Huntsman Marine Laboratory and the Department of the Environment Biological Station at St. Andrews, as well as the general environmental situation. Much of this work is contained in UNB and Mount Allison theses. Steer (1974) studied Forrester's Cove at the head of

Kennebecasis Bay, Burns (1976) specialized in the environment and biota of deep basins in Kennebecasis Bay, in the same year Mouland (1976) examined salt water replenishment in Kennebecasis bay and Metcalf (1976) looked at detritus and its utilization as food. Gillis (1978) examined benthic ecology in the Saint John mainstem, and in the same year London (1978) looked at general benthic conditions in Kennebecasis Bay. Very recently, Page (1979) looked at the characteristics of an internal density wave and its effects on the macrobenthos of Kennebecasis Bay, and Cunningham (1980) carried out a statistical analysis of benthic species in the Kennebecasis estuary. General physical, chemical and biological parameters of the estuarine system are given in Metcalf et al. (1976).

Physical Oceanography

There are two main factors controlling physical oceanographic conditions within the estuarine complex, the Reversing Falls sill and the total volume of fresh water flowing to sea. Figure 3 shows a longitudinal profile of the lower estuary and Kennebecasis Bay. There are about 5 m of water over the sill at slack tide, which occurs 2 hr., 25 min. either side of high water. At mean high tide, the estuary is about 2 m below sea level, and at mean low water about 5.3 m higher than sea level. Thus, inflow occurs over a much shorter period than outflow. At times of flood, a rise in estuary level of 3 m will result in continuous outflow. At times of lowest flow, salt water input reaches a maximum. As shown in Figure 4, peak river levels reflecting flow are reached in April and May, with a second rise in November and December. Minimum river flow occurs normally in July and August. The restriction of the Reversing Falls reduces tidal amplitude above the falls to 40-70 cm.

The fast currents and extreme turbulence associated with the Reversing Falls result in virtually complete mixing of the water in that area. This is reflected in typically vertical temperature-salinity (TS) profiles taken above or below the falls (Figure 5 a) at slack water on a falling tide.

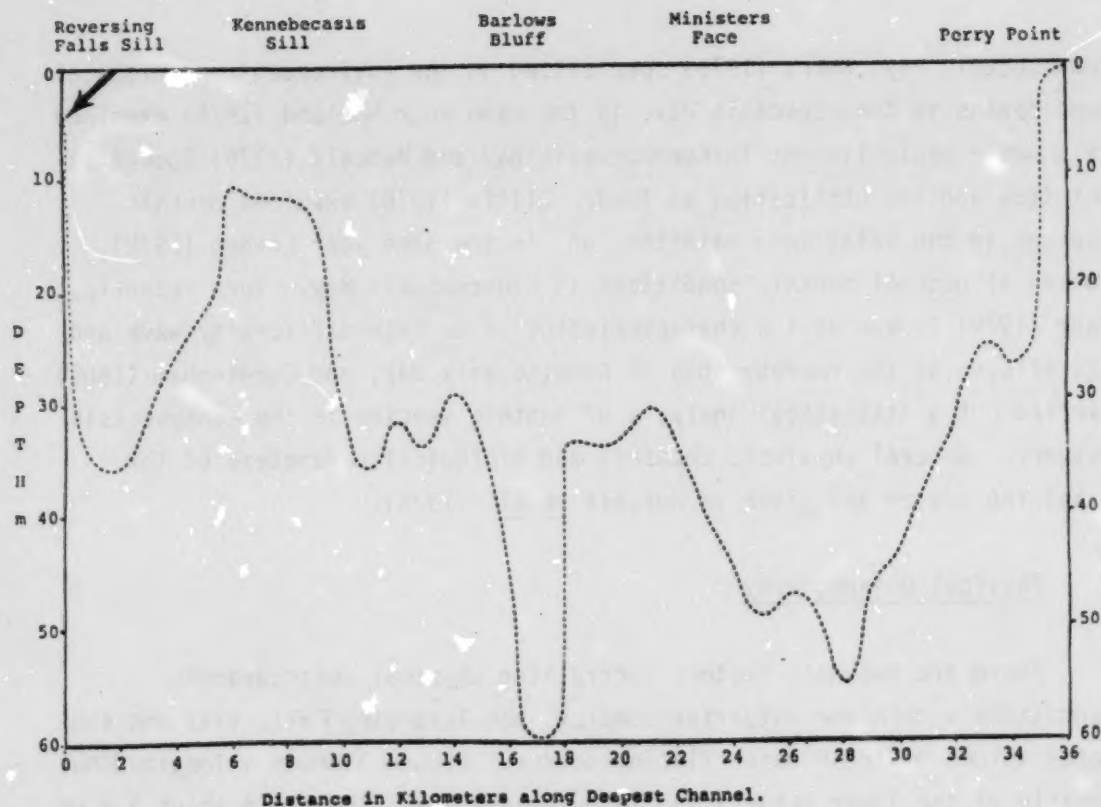


Fig. 3 - Depth profile of the lower Saint John River and Kennebecasis Bay.

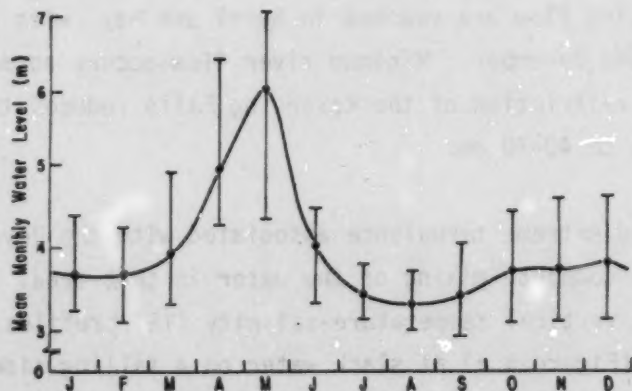


Fig. 4 - Maximum, minimum, and average mean monthly water levels in the Saint John River at Mactaquac Dam for 1966-75 (from Water Quality Branch, Environment Canada).

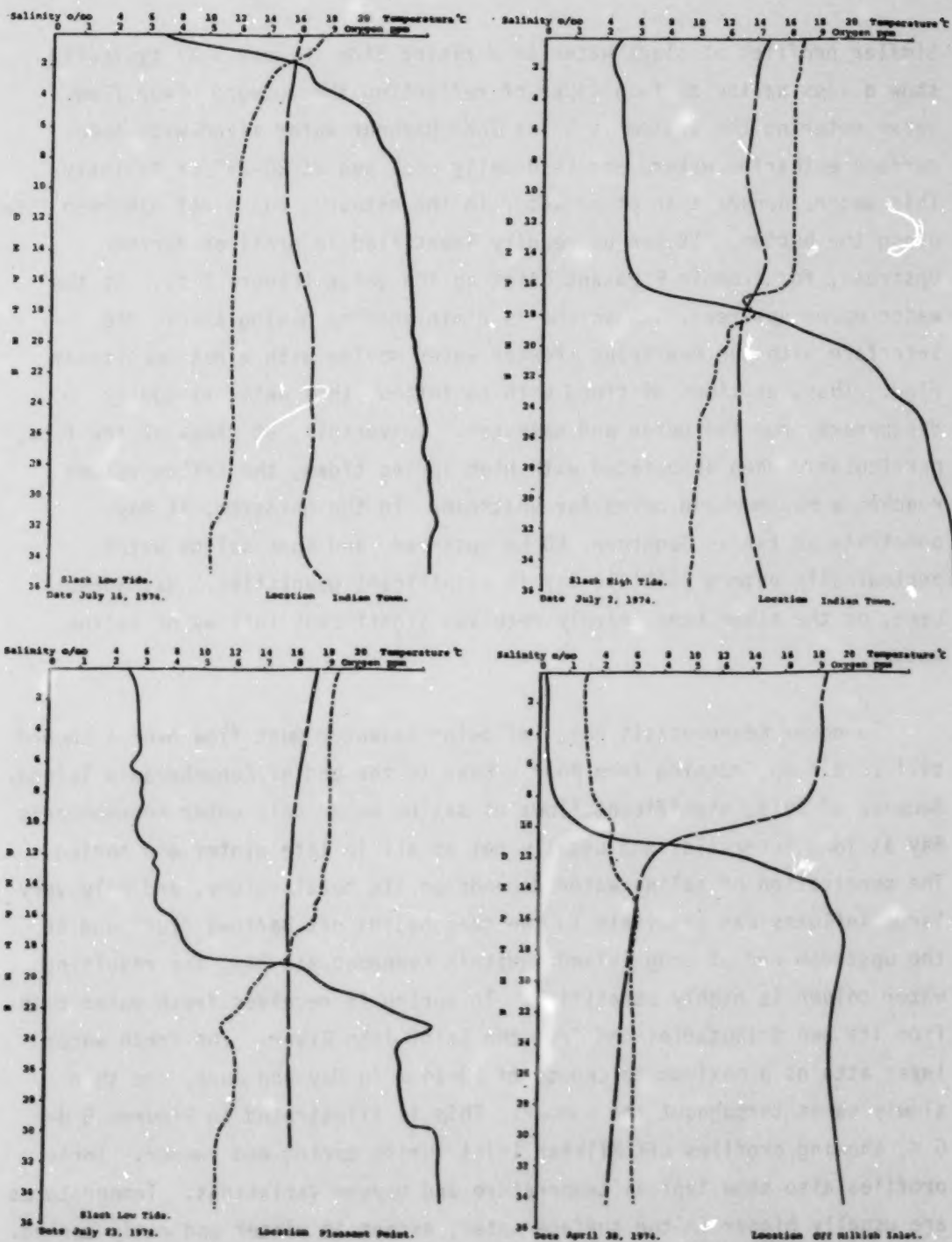


Fig. 5 (a)-(d) - Hydrographic profiles of the Saint John Estuary; July and April, 1974.

Similar profiles at slack water on a rising tide (Figure 5 b) typically show a less saline surface layer of reflecting the outward river flow. Water entering the system is Saint John Harbour water mixed with some surface estuarine water, and is usually cool and at 20-24‰ salinity. This water, denser than other water in the estuary, has a net upstream flow along the bottom. It can be readily identified in profiles further upstream, for example Pleasant Point in the gorge (Figure 5 c). As the water moves upstream, its volume is diminished by mixing across the interface with the overlying fresher water moving with a net downstream flow. Thus, at times of flood with no inflow, this water virtually disappears from the gorge and mainstem. Conversely, at times of low flow, particularly when associated with high spring tides, the inflow volume reaches a maximum and moves far upstream. In the mainstem, it may penetrate as far as Gagetown, 60 km upstream, and some saline water periodically enters Bellisle Bay in significant quantities. Washademoak Lake, on the other hand, rarely receives significant inflows of saline water.

To enter Kennebecasis Bay, inflowing seawater must flow over a second sill 10 m deep, running from Boar's Head to the end of Kennebecasis Island. Because of this, significant flows of saline water only enter Kennebecasis Bay at long intervals, and usually not at all in late winter and spring. The penetration of saline water depends on its total volume, and only very large influxes can penetrate to the deep basins off Barlows Bluff and at the upstream end of Long Island. Within Kennebecasis Bay, the resulting water column is highly stratified. In spring it receives fresh water both from its own tributaries and from the Saint John River. The fresh water layer attains a maximum thickness of 10-14 m in May and June, and then slowly wanes throughout the summer. This is illustrated in Figures 5 d-6 d, showing profiles off Milkish Inlet during spring and summer. These profiles also show typical temperature and oxygen variations. Temperatures are usually higher in the surface water, except in winter and early spring. Oxygen is always high in surface water and variable, but often low in

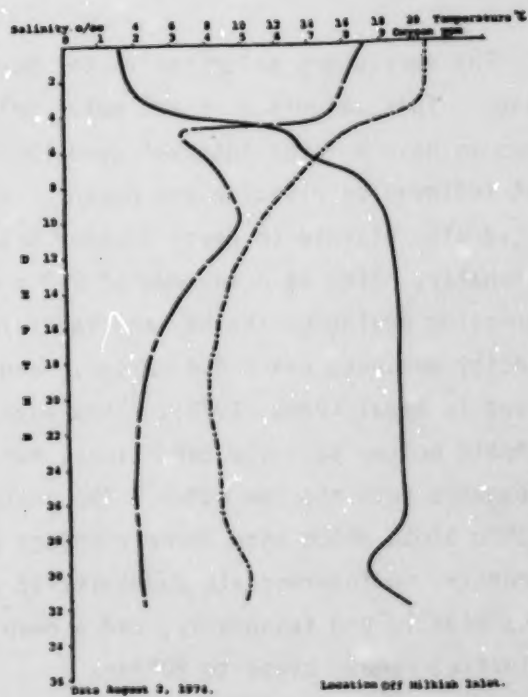
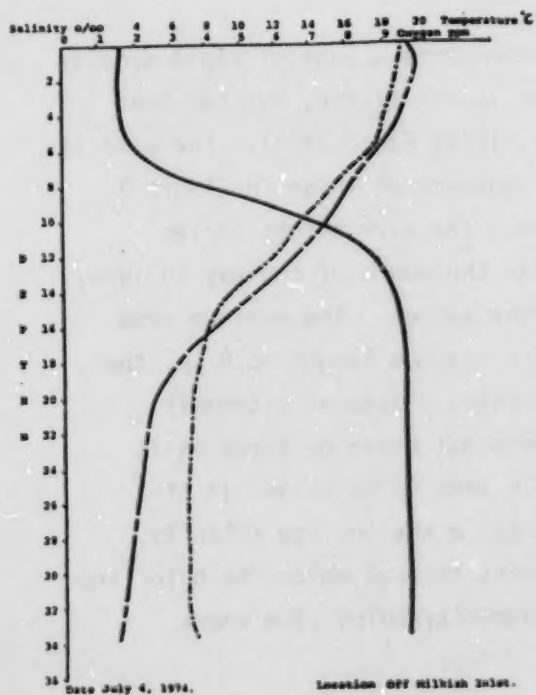
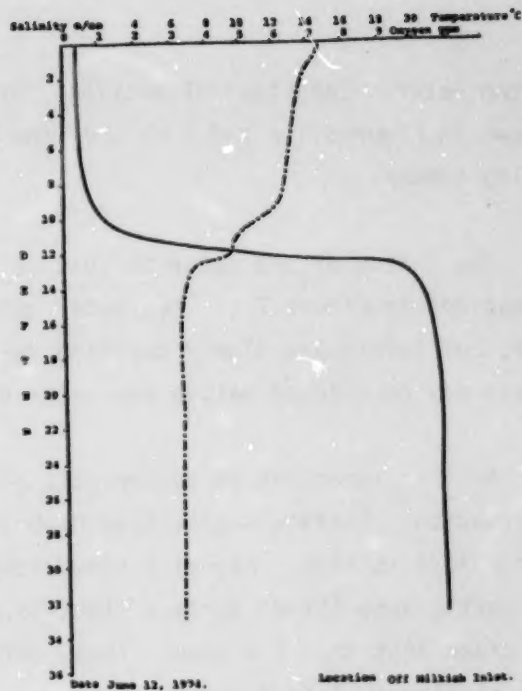
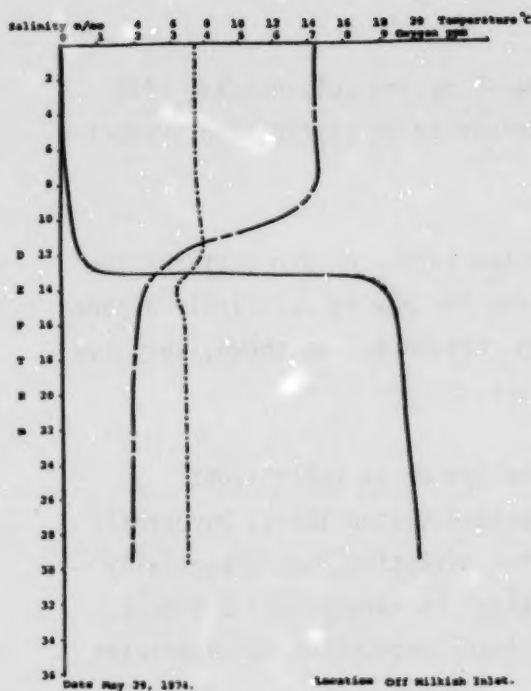


Fig. 6 (a)-(d) - Hydrographic profiles of the Saint John Estuary; May to August, 1974.

bottom water. Longitudinal sections for May-June and July-August, 1974 (shown in Figures 7 a and 7 b) show the pronounced stratification, reducing during summer.

The influx of sea water is best reflected in the oxygen distribution summarized in Figure 7 c. Sea water entering the bay is relatively oxygen rich, but levels are slowly depleted during residence. As shown, very low levels may be reached before new water enters.

Another important characteristic of the system is rapid light attenuation. Surface waters have high suspended seston loads, especially when runoff is high. Figure 8 summarizes the situation, but essentially the photic zone (1% of surface light intensity) is rarely over 3 m deep, and often less than 2 m deep. Thus, net primary production is restricted to a shallow surface layer.

The very sharp halocline in the bay represents a zone of rapid density change. This interface in the water column is not static, but has been shown to have a large internal wave (Steer, 1974; Page, 1979). The wave is best followed by plotting the depth of an isotherm as shown in Figure 9, but is also visible in depth sounder traces. The wave height varies seasonally, being at a maximum of 6-7 m near the mouth of the bay in June, decreasing moving up the bay and later in the summer. The maximum wave velocity measured was 104.4 cm/sec., and its maximum length 41.0 km, the period is tidal (Page, 1979). This wave creates a zone of extremely unstable bottom salinity conditions, but does not break or surge as it propagates into shallow water. The unstable zone is reflected in its benthic biota which show three distinct zones, a shallow low salinity community, an intermediate community at depths through which the halocline moves tidally and seasonally, and a deep community below 15 m where salinities remain close to 20‰.

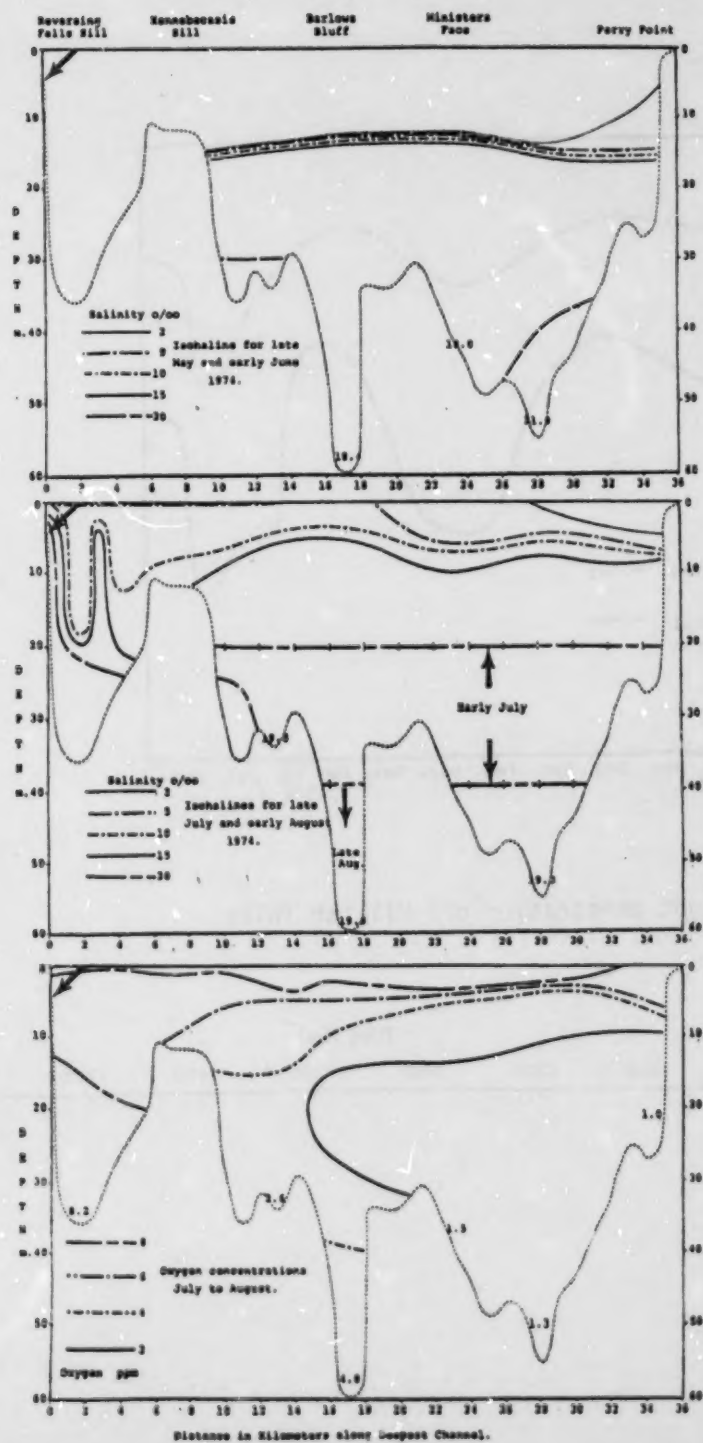


Fig. 7 (a)-(c) - Depth profiles of the lower Saint John River and Kennebecasis Bay.

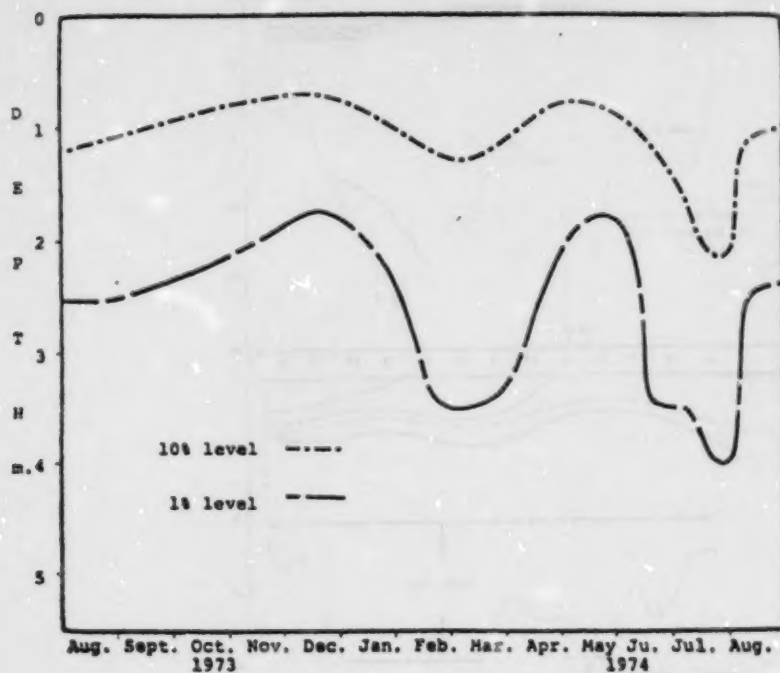


Fig. 8 - Light penetration off Milkish Inlet.

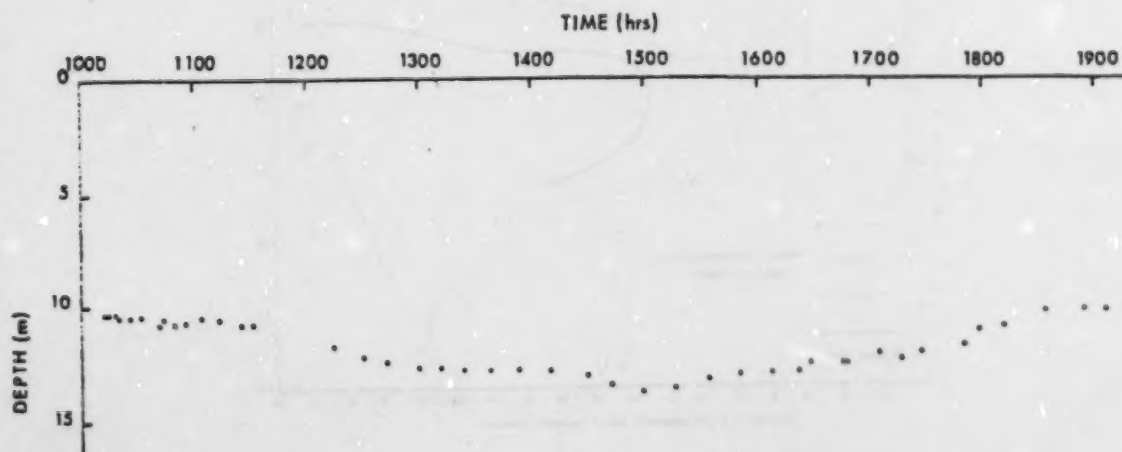


Fig. 9 - The Kennebecasis Bay internal wave as shown by the position of the 9.5°C isotherm off McCormack Cove; June 21, 1977.

Sediments throughout the floor of Kennebecasis Bay are basically silt-clay mixtures with virtually no particles over 80 microns. A typical set of sediment profiles for McCormacks Cove is shown in Figure 10. Along shores and on the Boars Head sill, sands predominate.

Biotic Conditions

Physical conditions create an environment in Kennebecasis Bay which places severe restraints on the biota. The salinity is reduced, light is virtually absent below 3 m, oxygen falls to very low levels in deep basins, and water exchange is very limited. The fact that primary production is confined to a seaward moving basically fresh layer, overlying saline water, is probably the main controlling factor. The exchange of organisms, detritus and other possible food materials between the layers has never been investigated. Although Metcalfe (1976) did examine the role of detritus in deeper water, he was not able to identify its source.

The benthos reflects the peculiar unstable condition of the water mass. There is a striking gradient moving upstream from the mouth to the head of the bay in which diversity, abundance and biomass all decrease. Figure 11 shows this decline for numerical standing stock as shown by grab samples (Burns, 1976). Page (1979) was also able to show distinct vertical differences in benthic communities. He defined fresh, intermediate and bottom water zones each with its own assemblage of biota. Curiously, he found diversity in the unstable, intermediate zone to be somewhat higher than in the more stable bottom water. This may reflect severe limitation in bottom water due to seasonally low oxygen and generally poor food supply.

The fresh water zone is characterized by fresh water pond weeds and the gastropod Hydrobia minuta. The intermediate zone is dominated by the bivalve Macoma baltica, and the polychaete Aglaophamus neotena. Two other polychaetes Scolecopelides viridis and Nereis succinea are consistently

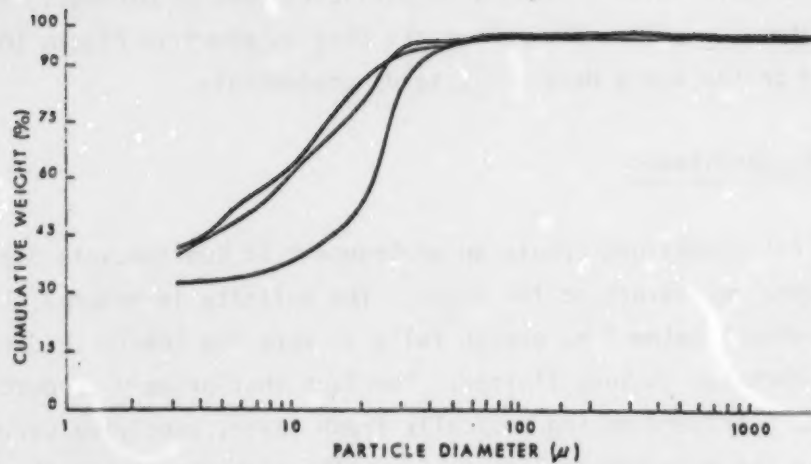


Fig. 10 - Typical Kennebecasis Bay sediment profiles from McCormacks Cove.

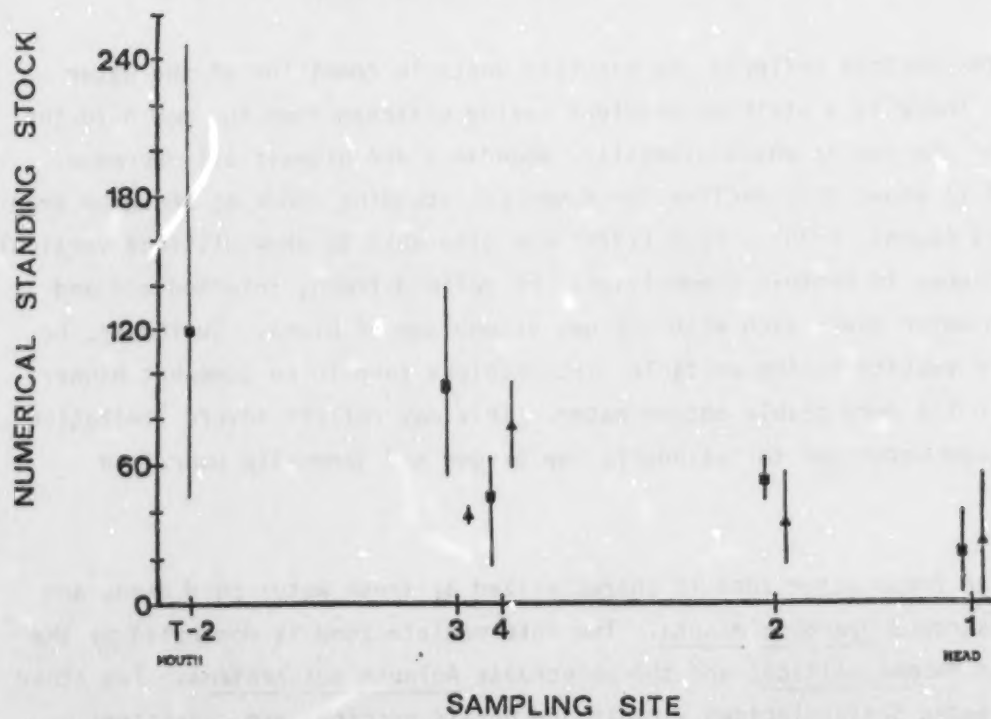


Fig. 11 - Average numerical standing stock per 0.5 m². Vertical lines represent minimum and maximum numerical standing stocks. Squares show results for 1974, triangles show results for 1975.

present but not abundant, and Mya arenaria, the soft shell clam, is locally abundant. The bottom water zone is characterized by the polychaete Trochochaeta carica; also in this zone are typically the bivalve Hiatella gallicana, the burrowing anemone Edwardsia elegans, the sponge Suberites ficus and the holothurian Caudina arenata. Fifteen or so other species occur more rarely. Statistically, significant differences in benthic abundance and composition are evident between years (Cunningham, 1980), and species are seen to radically wax and wane in samples. However, it is evident that there are aspects of long term stability, since several species have never been collected in this region, except in Kennebecasis Bay.

The epibenthos and zooplankton have received less attention than the benthos, but nevertheless show similar trends. One curious aspect of this group is that the shrimp Crangon septemspinosus is very abundant and large at intermediate depths near the bay mouth. Within the deeper waters, two crustaceans, Erythrops erythrophthalma and Parathemisto gaudichaudi, show great variations in abundance. In 1974, for example, P. gaudichaudi was always among the three most numerous species (Burns, 1980), but has declined since and is now rare. Other elements of the biota show similar variability.

Summary

In summary, the Saint John-Kennebecasis estuarine complex is a unique and interesting body of water. Kennebecasis Bay is a fjord-like body and receives only periodic replacement of deeper water. This results in critically low oxygen levels at times. Anoxia has never been observed and has probably never occurred, but increasing organic pollutant loads place demands on dissolved oxygen and place the system in jeopardy. All aspects of this estuarine complex deserve further study.

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QUESTIONS

Audience: You mentioned measuring 0.5 ppm oxygen in the bay in deep sections. Does this occur in summer?

Martin Thomas: Yes, July or August. Usually in late July we see these very low oxygen levels in the deep basins, particularly as we go up stream.

Audience: Does there appear to be a correlation between these low oxygen levels and the degradation of the river since records were first kept?

Martin Thomas: I am not aware of oxygen monitoring having been done before the time of the Trites survey (see References), which really is not far enough back. So you can only go by the biological evidence of those organisms which have managed to survive in that system. We have not had

evidence of anoxic conditions in the past, but in the last 10 years, since we have been measuring oxygen levels, the system has been on the verge of anoxia at least three times. One predicts, "By next week it is going to be anoxic", however, with the next week comes a little inflow of sea water. Anoxia has never actually occurred, but from our observations one would certainly predict it if things continue in the way they have. The combination of a very dry summer and extra organic pollutants might tip the balance. This condition has also happened in certain estuaries in Europe; for example, Oslo Fjord has occasionally suffered this fate.

Dave Wildish: There it is, that is a seasonal occurrence. You have depletion followed by mortalities, with subsequent recolonization by organisms.

Martin Thomas: You can argue against the possibility of recolonization in the Saint John River because we have species of fish that do not live in the local environment. It would seem that we have not had the anoxic conditions yet.

Leonard Wilson: How far up the river is it saline; as far as Gagetown?

Martin Thomas: I think just a bit above Gagetown; sometimes it extends into Belleisle Bay, but I don't think it gets into the Washademoak.

Mike Dadswell: I have determined a couple of parts per thousand in Washademoak.

Martin Thomas: That is probably a fairly rare occurrence.

Mike Dadswell: As soon as low water levels occur, it is fairly common.

Martin Thomas: We had a very dry summer two summers ago and the salt water got above the head of Kennebecasis Bay, up about Hampton at that time, and

a little salt wedge was created at the head of Kennebecasis Bay off all the fresh water weeds and fresh water mussels. You get this with very dry weather and limited fresh water inflow; then the salt water extends a long way up stream.

Leonard Wilson: Does it go up the Kennebecasis River the same as it does in the Saint John?

Martin Thomas: It goes a significant way up the Kennebecasis at those times. In early spring you would find no saline water at all.

Jim Hayden: How fast does the wave of salt water travel?

Martin Thomas: That internal wave speed was about 100 cm per second maximum.

Leonard Wilson: In your findings did you ever find any lime deposits in the Saint John River system?

Martin Thomas: I haven't, other people may have.

2.4 Trace Metals in Sediments of Saint John Harbour

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Distribution and level of selected trace metals (Cu, Zn, Pb, Cd, Mo, Ni, Mn and Hg) in surficial sediments of Saint John Harbour were studied to determine the extent of anthropogenic input and to estimate the effects of dumping dredged material in the outer harbour. Mercury and cadmium are of special concern, since the disposal of dredge material containing these two elements is strictly regulated under the Ocean Dumping Control Act.

The mean (range) concentrations of the metals in the sediments from the inner harbour are given in Table 2, and compared with those from other geographical locations. The levels of all metals in the sediments are low. The levels for both mercury and cadmium in Saint John Harbour sediments are well below the permissible limits of 0.75 and 0.6 mg/kg sediment, respectively, under the Act.

The metal levels in the sediments from different areas within the harbour (Table 3) indicate that, though not yet significant, there is a distinct detectable anthropogenic input in the Courtenay Bay area. The metal levels are significantly ($p < 0.05$) higher than in other parts of the study area, and gradually decline towards the outer harbour. The mean values of the trace elements in the harbour are very similar to the metal levels in the unpolluted Bay of Fundy (Loring, 1979). Trace metal levels at the dump site are significantly lower than in the Courtenay Bay area, though the bulk of the dredge material originates there and is possibly dispersed easterly and southeasterly with water movement (Neu, 1960).

Table 2 - Metal content (microgram per gram dry weight) of sediments from various geographic locations (ND = non detectable).

Location	Cu Mean (range)	Zn Mean (range)	Pb Mean (range)	Cd Mean (range)	Mo Mean (range)	Ni Mean (range)	Mn Mean (range)	Hg Mean (range)
Inner Harbour (all samples) n = 78	15.9 (5.8-40.7)	53.3 (23.5-105.7)	24.3 (6.3-66.8)	0.16 (0.01-0.61)	3.13 (1.0-10.6)	16.3 (5.2-40)	296 (131-911)	0.04 (<0.01-0.3)
(a) Grand Bay n = 23	11.1 (7.3-20.6)	41.2 (23.6-87.4)	24.3 (10.4-36.0)	0.18 (0.08-0.31)	3.3 (1.1-7.2)	17.1 (5.2-29.0)	328 (131-910)	0.04 (0.01-0.06)
(b) Harrows (above Reversing Falls) n = 15	14.5 (9.4-29.9)	41.9 (28.3-52.5)	20.5 (6.3-33.2)	0.14 (0.05-0.33)	2.9 (1.5-5.2)	15.8 (9.3-28.9)	248 (131-458)	0.02 (0.01-0.05)
(c) Rodney Terminal n = 13	12.6 (9.5-17.4)	46.7 (33.9-59.1)	20.9 (13.5-38.5)	0.10 (0.01-0.31)	3.5 (1.4-7.1)	16.3 (8.5-39.7)	307 (243-412)	0.02 (0.01-0.04)
(d) Courtenay Bay n = 27	20.6 (8.7-40.7)	65.9 (43.7-105.7)	30.8 (9.3-66.8)	0.22 (0.06-0.61)	2.6 (1.0-10.6)	16.7 (6.8-26.5)	285 (180-445)	0.03 (0.01-0.30)
Dumfries n = 6	11.5 (8.1-22.4)	44.2 (27.9-66.3)	18.5 (11.9-38.0)	0.06 (0.03-0.09)	4.2 (2.9-5.0)	15.1 (9.2-26.7)	283 (201-360)	0.03 (0.01-0.04)
Outer Harbour n = 51	14.6 (7.7-106)	64.8 (29.2-442)	-	0.07 (<0.01-0.40)	-	-	-	0.03 (<0.01-0.09)

Table 3 - Metal content (microgram per gram dry weight) in Saint John Harbour sediments (n = number of samples).

Location	Cu Mean (range)	Zn Mean (range)	Pb Mean (range)	Cd Mean (range)	Hg Mean (range)	Mn Mean (range)	Hg Mean (range)	Reference
UNPOLLUTED								
Saleway Firth:								
(a) Salton Parkon Bays	10 (5-18)	63 (24-105)	37 (10-72)	<1.0 (ND-2.4)	<2 (ND-2)	38 (20-85)	360 (180-720)	Perkins et al. (1973)
(b) Alloddy Beckfoot	16 (0.5-48)	74 (36-112)	56 (24-76)	2.9 (2.4-4.0)	1.0 (0.2-2.4)	17 (10-22)	233 (110-370)	Perkins et al. (1973)
(c) Urr Water Estuary	7 (2-12)	41 (25-65)	21.5 (11-34)	0.9 (0.6-1.3)	-	9 (6-14)	333 (221-567)	Taylor (1976)
Bay of Fundy	15 (5-32)	51 (18-104)	20 (8-42)	0.22 (0.03-0.52)	-	15 (3-46)	0.03 (0.02-0.09)	Loring (1979)
Miramichi Estuary	27	219	83	-	-	45.4	417	Wiley and Fitzgerald (1980)
Marine Clays	25	165	80	0.21	8	275	6700	Bowen (1979)
Mean Sediment	33	95	19	0.17	2	52	770	Bowen (1979)
Saint John Harb. (Inner Harb.)	16 (6-41)	53 (24-106)	24 (6-67)	0.16 (0.01-0.61)	3 (1.0-11)	16 (5-40)	296 (131-911)	This Study
POLLUTED:								
Dredge Spoils:								
(a) Thames Estuary	46 (7-120)	220 (48-450)	93 (13-250)	1.8 (0.2-4.8)	-	50 (17-82)	0.78 (0.3-3.5)	Murray and Norton (1979)
(b) Herring Docks	115 (60-150)	480 (200-500)	194 (150-260)	1.9 (1.0-3.5)	-	48 (38-55)	3.2 (0.3-5.9)	Murray and Norton (1979)
Seven Estuary	38	260	119	-	-	36	1820	Chester and Stoner (1975)
Derwent Estuary (Australia)	(400-10100)	(<50-104000)	(<5-150000)	(0.5-1400)	-	(0.3-42)	(0.8-8900)	Bloom and Ayling (1977)
Narragansett Bay, U.S.	53 (26-94)	110 (53-168)	44 (17-81)	0.47 (0.06-2.45)	-	18 (6-34)	-	Eisler et al. (1977)
Bellevue Harbour	-	1710 (700-5250)	-	32.18 (8-74)	-	-	-	Loring et al. (1980)

In summary, the concentration of the trace metals in the sediment of the study area seems to be well within the range of natural variation, and the adverse effects of dumping relatively clean sediments into the sea water are expected to be minimal.

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- Neu, H.A. 1960. Hydrographic Survey of Saint John Harbour, New Brunswick. N.R.C. Engineering Rept. MH-97, 196 p.

QUESTIONS

Audience: Do you have any core samples which show a vertical gradient in metal concentrations?

Shankar Ray: No, these were not taken, but you would probably expect it. There are many references in the literature where core samples have been taken. That is one way of determining what may be the unpolluted background, but we have not done that.

Audience: I recall seeing a study on metals in the St. Croix estuary done by the University of Maine. Are you familiar with that? As I recall there were high metal levels in that estuary!

Shankar Ray: Yes, I am familiar. One of the problems with heavy metal determination is with the laboratory doing it. I am a member of the Laboratory Evaluation Committee in the Atlantic Region. Only 20% of the laboratories evaluated were able to give correct cadmium values, which is of prime importance as far as the Ocean Dumping Control Act is concerned for judging permits. Why does it happen that when 0.2 to 0.3 ppm cadmium is present in the sample, some laboratories report 4 to 5 ppm? I won't comment beyond that! When you want to compare data you have to find out what kind of reference material was used in terms of laboratory analyses. When river mud is analyzed, the matrix is completely different from ocean sediments, and it is therefore difficult to compare the St. Croix results with those of Saint John.

2.5 Oceanography and Sedimentology in the Saint John Harbour

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Ray has thoroughly described the chemistry in the harbour of Saint John and has touched on the current patterns and dispersal of sediment from the dump site. I want to restrict my discussion to the bottom currents of Saint John Harbour and their effect on the bottom sediment regime. This will inform us about the effects of the dump site on the bottom sediment regime in the harbour. I will conclude with a brief discussion of the suspended sediments.

As mentioned earlier today by Martin Thomas, in his description of the upper estuary, the current regime in the harbour is extremely complex. It is dominated by two large forces, the river flow outward and the Bay of Fundy tides. These interact to produce a residual current structure (that is the average current when the fluctuating tidal components are removed), which is predominately outward at the surface, resulting from the river flow across the width of most of the harbour mouth. This is combined with a bottom residual current, very strongly inward in this portion of the harbour. It results in a general overturn of the harbour waters with the Bay of Fundy water entering at the bottom; river water mixed with Bay of Fundy water leaving at the surface. There is a further interaction with the residual longshore current driven along the Bay of Fundy coast toward the southwest, which generates a clockwise rotation of bottom residual currents in the harbour.

The effect of this system can be seen in the directions of bottom stress vectors. However, because of the large variation in the magnitude of the current between the top of the water column and the bottom, a calculation of stress on the bottom could be seriously in error in terms of

direction and magnitude if one averaged the whole water column. By considering only currents nearest the bottom, we calculated stress by using an empirical formula developed by investigators of the Hydraulics Research Station in the U.K. in an investigation of the Thames Estuary. There they measured stresses and the behaviour of mud from the Thames Estuary in flumes. They found that Thames mud would erode from the bottom when current-generated stresses exceeded 2 dynes/cm^2 , and that Thames mud would deposit from suspension on the bottom when the bottom stresses fell below 0.6 dynes/cm^2 . Between those two values, suspensions would not deposit and bottom deposits would not erode. This condition of suspensions and bottom deposits was a type of stable condition in which there could be transport of bottom sediment in suspension, provided it was already in suspension.

We found that stresses actually vary over the harbour through the tidal cycle. At high tide when water currents are at their maximum (slack water), there is only a small area in the harbour where values of bottom stress are such that one would expect erosion of mud similar to Thames mud. These specific threshold values are pertinent only to a material like Thames mud, which is similar to the material that is depositing in Courtenay Bay and is currently being dumped at the Black Point dump site. At high tide, erosional stresses occur only at one point in the outer harbour. In other areas, conditions are suitable for deposition of material during this period. It is difficult to estimate the rate of deposition. At half-falling tide, currents increase so much that the whole area is subject to erosional stress. The depositional areas retreat toward the coastline. It is necessary to qualify these numbers somewhat at this point. Close to the coastline, wave generated turbulences, which may exceed those of the tidal generated currents, are going to affect the bottom; perhaps in the area which is exposed, to the southwest, to a fairly energetic wave field under average conditions. Therefore, these numbers are only valid up to a certain distance from the coast. Most of the harbour during half-falling tide appears to be undergoing transport of

sediment only, that is neither deposition nor erosion. At low tide the currents do not entirely cease. Bottom currents do not always resemble those of the surface. There can be considerable water motion, even in the absence of rising or falling tides. There is a large erosional area, at low tide, extending across the dump site area and out into the bay. Most of the area from Red Head to the breakwater is depositional as is most of the Partridge Island to Manawagonish area. The really interesting part of the cycle occurs at half-rising tide, because this is the period of maximum bottom stress. The portion of the harbour that is capable of eroding Thames or Courtenay Bay type mud is at its maximum extent. The dump site area, in particular, is distinctly erosional.

The effects of these currents on the actual state of the bottom are examined by considering the sediment texture of the bottom over the harbour. The numbers we have generated require some explanation. They indicate the fineness of the sediment on the bottom and are obtained by taking a bottom sediment sample and measuring the numbers of particles in all the size ranges using a Coulter counter; then calculating the area of the particles, assuming that they are spherical; and adding these areas over the entire size range of the particles. This gives a number which is an approximation of the total particle surface area per gram of sample. It is a number which is also useful in estimating the significance of trace metal concentration, when the metal is adsorbed onto the particle's surface. If trace metal concentrations are compared to the particle's surface area, some significant variations in trace metal concentrations in the harbour can be found.

The numbers obtained for total particle surface area indicate fineness. For example, a sediment sample that consisted entirely of 10 micron spherical particles of standard density, would have an area somewhat over 2000 sq cm per gram (and would be a fine silty clay). In a sample consisting entirely of about 100 micron size particles, a more sandy sediment, that number is reduced by a factor of 10 to slightly over 200 sq

cm per gram. The actual variation of these numbers over the harbour clearly shows a very distinct, high degree of fineness in Courtenay Bay sediments (numbers up to 2000 sq cm per gram in Courtenay Bay, where the sediment contains a large number of particles that are, in fact, much finer even than 10 microns and a large number of particles extending into the range of 1 micron and even lower. These numbers indicate very fine sediment with high organic content.) Over much of the outer harbour numbers vary from 500 to 1000 sq cm per gram. These numbers are typical of a sediment sample containing sand and a small amount of silt and clay. High numbers indicating fine sediment occur again in the outer harbour area as one approaches the dump site. A number from a sample collected close to the dump site approaches that from some of the finer sediment in Courtenay Bay - not quite as fine as the finest sediment in Courtenay Bay, but close to it and distinctly higher than the average in the outer harbour. The anomalous nature of that can be seen in comparing these numbers with the previous maximum bottom stress picture which shows the maximum erosional stresses at half-rising tide cutting right across the area of fine sediment. This clearly indicates that this area of fine sediment is anomalous and occurs for reasons other than the physical conditions in the water column. The only reason for the occurrence of such fine sediment in this general area is that the sediment is put there. The supply is continuously maintained through dumping, and continuously eroded and carried away by the harbour currents. Therefore, the extent of the physical anomaly is probably limited to the immediate area of the dump site. Other areas of moderately fine sediment occur, but the stress values are somewhat lower, i.e., either neutral or depositional.

To go from the long term effects on bottom sediments at the dump site, to the more instantaneous picture of the suspended sediment regime in the harbour, one can indicate the natural suspended sediment transport in the harbour from measurements that were made by H. Neu in 1958. A fairly comprehensive harbour survey was done at that time with water column current profiles taken at about 60 stations throughout the harbour. At the

same time suspended sediment concentrations were measured at several points through the water column. These permit a rough calculation of sediment transport by currents over a tidal cycle. Even if these numbers are not entirely accurate, I believe that they at least indicate the order of magnitude of the numbers that we are dealing with. These numbers indicate sediment transport in kilograms per tidal cycle calculated on the basis of water moving through a 300 meter horizontal section and through the entire vertical column. For comparison, one can take the yearly dredging budget in the harbour and divide it by the number of tidal cycles per year to arrive at the number of kg of sediment put in per tidal cycle. Among the pertinent features of this picture are: a fairly large transport upstream during the summer period of 1958 which characterizes the strong bottom currents going upstream under the Reversing Falls; a small but significant inward transport of sediment at the bottom; and a large and significant outward transport of sediment in the area of the dump site. One passing point regarding this inward transport of sediment is that it may well constitute the source for sediment which is depositing constantly in Courtenay Bay. The transport of sediment at this point is approximately equal to the dredging budget. Under normal conditions measured in the summer and fall of 1958, when currents and wave energy could be expected to be quiescent and suspended loads and transport roughly at a minimum in the seasonal cycle, a comparison can be made between these sediment transports and the natural sediment transport in the outer harbour area. All of these are an order of magnitude bigger than the dredging quantity per tidal cycle. Thus, the sediment being eroded from and leaving the dump site is likely to be dispersing and mixing with a natural sediment load which is in concentration one or more orders of magnitude larger than the concentration generated by the dump site erosion. Therefore, at present dredging levels, eroded sediments contribute little to the natural system and are probably a negligible source of suspended sediments.

Further data is available on suspended sediment taken at several sediment trap locations in the harbour. The sediment trap mooring

consisted of a concrete block at the bottom with an acrylic tube mounted alongside a one metre long steel shaft tied to a buoy at the surface. Four traps were moored at locations in the harbour. Their cylinders were replaced every two weeks for over a year. Unfortunately I do not have the data with me, but they show inorganic and organic carbon concentrations, lead, zinc, cadmium and mercury concentrations and total amount collected varying over the year - resulting in a great deal of scatter in the data, a certain amount of significant variation with the seasons, but no significant correlation with the amount of material dumped at the site by the dredging projects.

While I cannot comment on the overall biological effects or chemical effects on the harbour, I think it is reasonably clear that the physical effects of the dumping operations, although noticeable, are restricted to the immediate vicinity of the dump site.

QUESTIONS

Dave Scarratt: Can you review how you calculated your 2 and 0.6 dynes/cm² threshold levels?

Don Bezanson: These are simply convenient numbers which were arrived at by the Hydraulics Research Station in Wallingford on the basis of flume tests.

Dave Scarratt: I understand that; how do you then tie them to the conditions in Saint John?

Don Bezanson: I was using their empirical formula for calculating stress from water currents on the basis of the measured currents taken by H. Neu in 1958.

Dave Scarratt: Is there any way of doing a sort of retrospective calculation or estimation of the currents, and hence a calculation of the approximate positions of the threshold levels or conditions as they existed before the construction of the Partridge Island causeway and the Courtenay Bay causeway?

Don Bezanson: That could be done if you are willing to accept a certain margin of error.

Dave Wildish: There is a slight problem, I think, in the data. You showed at one point some sediment data, and some surface area values, and they do not coincide with the surface areas of the Thames mud situation; thus, the dynes/cm² threshold may not apply in the different sediment areas. They are quite different; the one in Courtenay Bay itself is quite fine.

Don Bezanson: In Courtenay Bay the sediment is very fine and the stresses are also very low. Courtenay Bay is the only place in the harbour where currents actually approach zero at points in the tidal cycle. There is no contradiction as far as Courtenay Bay goes. Were you referring perhaps to slightly outside? Well, in this area one has moderately fine sediments. I think we have to be a little careful here. Samples may be taken from isolated pockets since this area is actually quite rocky and there is a reef there. It is probably inaccurate to characterize it as being an area of fine sediment entirely, even though there is quite a bit of fine sediment there. But, in terms of stresses, the erosional stresses are actually somewhat out beyond that, restricted to the deeper portions of the channel.

Alan McIver: Could you comment on the significance of extreme erosional conditions in storm conditions?

Don Bezanson: Well, certainly the values in my study represent stresses calculated from current measurements only. During storms, wave energy is

added to the total stress experienced by the bottom, which could probably raise much of the bottom of the outer harbour to erosional stress levels; even at stages of the tide when currents would be incapable of doing it by themselves. That would be an additional source of erosion and transport.

Alan McIver: Would they tend to follow the same patterns, or would wind driven erosional forces change the pattern?

Don Bezanson: I don't think wind would influence the direction of residual motion much in the harbour. What would greatly influence the direction of sediment transport would be the state of the tide on which the storm hit, and at which the sediment was coming into suspension.

Dave Scarratt: This is like a very fine scripture. Each time we talk, we have one more layer revealed. I am wondering whether or not some of the things that we have learned earlier perhaps might be getting into the backs of our minds. I recall one stage when you were first looking at this question of surface area. You detected in the Courtenay Bay samples a very high ratio of zinc, and I seem to recall that you were getting some evidence that those particles were being redeposited inshore in areas which are not included in that section, but which you suggested was perhaps currently influenced by it. I wonder if you could comment on that?

Don Bezanson: That is true. I don't have that data with me, but what I was doing with normalization of trace metal concentrations was looking for a metal which would be put into the sediment in sufficiently high rates in Courtenay Bay such that the trace metal concentration would then be so anomalous that it would constitute a tracer in the outer harbour area. And in looking at that, I found that zinc and copper were, in fact, high enough. Other metals such as cadmium and mercury had normal levels, and were not useful as tracers. I was dividing the area per unit gram numbers into my total trace metal concentrations, supposing that the metal was on the surface of the particle rather than incorporated in the body of the

particle as would result from it being an anomalous anthropogenic input to the particles. Those numbers came out significantly higher in Courtenay Bay, and they came out somewhat higher along that coast, providing an indication of anthropogenic input of zinc and copper into those sediments. However, I have not been able to distinguish whether the source is the dump site or perhaps the carrying of sediments from Courtenay Bay itself, or some other area. The chemical data also shows a very strong source from a little creek on the other side of the breakwater. Conceivably, it could be involved through wave erosion, and the clockwise residual regime could be carrying fine particles with high zinc concentrations into this area over here, as well. It could also be the dump site; I personally would bet on that.

2.6 Macro-Infauna Investigations in Saint John Harbour

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Abstract

Based on data from 26 stations in Saint John Harbour, comprising 205 grab replicates taken in 1973 and 1977, the area sampled has macro-infaunal associations characterized as follows:

Climax; (1) hard substrate association

Subclimax

(2) hard substrate, wood chips

Climax; (3) soft sediment association

Subclimax

(4) soft sediment, tidal impoverishment

(5) soft sediment, dredging activity

(6) soft sediment, dumping activity.

Of four recognizable sub-climax associations, three were due to anthropogenic influences, although much of the inner harbour consisted of a natural, tidal impoverished, macro-infaunal association. The presence of natural and anthropogenic influences, causing macro-infaunal impoverishment, makes it difficult to assign causes to sub-climax associations of macro-infauna. However, impoverishment in soft sediment due to dredging activity could be recognized by the presence of indicator species such as Capitella capitata and Nereis virens, which are first colonizers after the removal of sediment. These indicator species also occur at the dumping ground as exotics. As indicated by the limited distribution of exotics near the dumping ground and the distribution of organic carbon there, the affected area is small and of less than 1 km².

Before I begin, I will justify why I have been studying the animals that live on the bottom of Saint John Harbour. Basically there are two reasons for my interest. (1) The history of benthic studies in the harbour, the mouth of the Saint John estuary below the Reversing Falls begins, I think, in 1959 when Sprague first studied benthic animals in the area. His reason for studying them is the same today as it was then, that is to see whether there were any effects on the fauna caused by industries at the mouth of the Saint John River. Thus, 1959 was the date of the first study (11 stations), with further studies in 1961, 1973 and 1976. These dates are of benthic investigations which involve the infauna. Infauna are animals living in the soft sediments of estuarine and marine situations. (2) In temperate climates, like ours, the characteristic movements of energy in the marine ecosystem involves transport to the bottom where macro-infauna are involved in processing a substantial proportion of the marine ecosystem's energy; in distinction to systems in the tropics where most of the energy is cycled in the water column through phytoplankton, zooplankton and fish. In tropical ecosystems very little of the material actually reaches the bottom.

I was particularly interested in the dumping and Courtenay Bay areas because it is from the latter that most of the dredge spoils are taken. A salinity profile in the harbour shows the surface water to be less saline than the bottom water, which because of the sea water intrusion is more saline. At a different date in June, a quite complex salinity pattern was found. In the fall, at mid-tide, there was low salinity near the bottom.

I was also interested to know whether the current patterns regulated the kind of suspended solids levels seen. In fact, it appears as though that is not the case, and if you consider ATP concentration (an approximate measure of the bacterial or phytoplankton concentration in the water) at certain times of year, you find that ATP is independent of both suspended solids and a measure of the dissolved organic matter present in the water. However, in the fall, the ATP levels are quite closely correlated with the dissolved organic matter.

I have compared the kinds, density and biomass of macro-infauna present in the dredged area with those at control stations, and of course with those at the dump site. (There were three stations chosen to be close to the dump site.) Tidal currents in this area have a marked influence on both the distribution of the heavy metals and the tidal stresses near the bottom.

I found that the organic carbon levels indicate the dumping ground quite accurately. Samples from the vicinity of the dumping ground show high values, in fact on either side of the dumping buoy they are about 1.7%, decreasing to background levels which in most of the rest of the harbour are approximately 0.5 to 0.7%. The values in Courtenay Bay, where the dredged material originates, are all above 1.1% and in fact go up to 3%. So I think that in organic carbon we have a good tracer of dumping activity. Of course the organic carbon pattern will vary seasonally. Our samples were taken soon after the end of dredging, so one would expect considerable dredged material near the dumping buoys at this time.

As for the macro-infaunal benthic associations present in the harbour, five areas are very characteristic, and I will briefly try to explain them. In subclimax (2) (see Abstract), deep holes are filled with wood particles, ranging from small wood chips to 2 metre long pieces of bark. The surfaces of the wood chips and bark are covered with mussels, and the interstices of the wood particles are filled with large numbers of amphipods. Quite probably the amphipods feed directly on the surface micro-flora of the wood particles. In subclimax (5), following dredging, we see a typical disturbed environment in which species diversity, biomass and numbers are low. However, these low levels depend on how recently we sample after dredging. Two characteristic species here are Capitella capitata and species of Nereis, which seem to be first colonizers in the recently dredged area. They colonize very rapidly after dredging has occurred followed subsequently, if the system is left long enough, by invasive species that are present in the harbour generally. Subclimax (4) is the

main part of the inner harbour. The species here are typically impoverished in species diversity and numbers, and biomass is very low. I hypothesize that the reason for this impoverishment is the very high tidal stresses present in the harbour. It could be that the tidal currents prevent the establishment of suspension feeders by inhibiting feeding or that the instability of the sediment itself prevents attachment. So, do we call this a naturally impoverished area, or do we call it an area influenced by anthropogenic influences? We simply do not know! As we have seen, our interest in benthic biology dates from 1959, so circumstances when dock construction activities commenced in 1900, remain unknown. Tidal impoverishment is also present in Musquash estuary, and others have described a similar tidal macrobenthic impoverishment in the Bristol Channel, U.K. The dumping site in Saint John Harbour is also impoverished in macro-infauna, thereby raising the question, "How can one separate subclimax (4) from subclimax (6)?" Well, luckily dredging removes a number of Capitella worms, characteristic only of subclimax (5), and obviously if one is there at the right time such species show up in samples. We were there soon after dumping, and found worms living in this area; thus, we have an exotic species of worm which indicates dumping in this particular case. Capitella is absent in climax (3) and subclimax (4), so we do have a species indicating where dumping activities are occurring. Finally, climax (3) is an area where some suspension feeders, particularly ascidians, become dominant and actually reach quite high biomasses (of the order of 500 grams wet weight per m^2), and these are obviously able to tolerate the high currents. This may be regarded as the common benthic association for Saint John Harbour, and 200-500 gram/ m^2 wet weight is the average range of values for this particular region.

QUESTIONS

Gary Westlake: Did you detect any localized effects of the industrial discharges?

Dave Wildish: The study was not aimed at that. The study was really aimed at the dredge site and the dump site. The stations outside that were simply controls. Now I am sure that if we looked below effluent outfall, one could see impoverished zones. But, as I say, it is very difficult, having a background that is impoverished anyway, to recognize such distribution patterns.

Alan McIver: Would you care to speculate on the significance of the organic material at the dump site and possibly the sources of it - could it be sewage or wood material?

Dave Wildish: No, I don't know anything specifically about the kinds of organic matter there. The method used is a relative measure of readily oxidized carbon, based on potassium dichromate oxidation.

Alan McIver: Would you care to speculate further as to whether the organic matter was a net detriment or net benefit to the productivity of the area?

Dave Wildish: It is hard to do that for Courtenay Bay because it is regularly dredged. In terms of the dump site area, I imagine that every winter it is simply swept away. It does not increase the benthic productivity there.

2.7 Changes in Benthos and Bottom Types

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Most of the work that I will discuss today was not specifically directed towards Saint John Harbour. The area studied by us is a little more to the west. We began in 1973 with some follow-up work from the Lorneville Impact Study, for the New Brunswick Department of Fisheries. Since then, our other studies have provided us with complimentary information about the situation. We do not have many numbers or graphs. Most of the material presented today is based largely on direct observation during diving surveys. As a result, we have a fairly broad overview of how Saint John Harbour fits, in terms of the macro-benthos, with the rest of the Bay of Fundy, particularly the mouth of the Bay of Fundy.

When we first dived, in 1973, the Lorneville shore appeared so stark that we thought we had moved to another planet! If you compare the West Isles, Grand Manan, with the Saint John area, the difference is striking. The first thing that struck us was the heavy load of sediments both in the water and covering the bottoms (except in those areas which were heavily scoured). Incidentally, the animals were also covered. Interestingly enough, we arrived when the water was clear. A couple of weeks after our first dive we had a storm. Prior to the storm our visibility was probably 4 or 5 feet. After the storm we were diving with lights, without which our visibility would have been 2 or 3 feet. The sediments that appeared after a major southerly wind were extremely substantial. The interesting dives were our 100 foot spot dives; there was zero visibility. The bottom was surveyed in minute detail; you could not see another diver's light until he was about to run into you. That was striking to us, and perhaps I can expand on this later.

During our diving surveys we also did some chemical profiles: one along the horizontal, parallel to the Lorneville coast; and another one which we ran into Musquash and Lorneville Harbour. Assuming that the chemical analyses were correct, we discovered very interesting levels of all the metals mentioned here. At that time, the metals centered around Coleson Cove at certain times of the year and diminished at other times of the year. It was a total mystery to us, but it appeared as if the metal levels were related to something happening in Coleson Cove at that time. The only thing that was happening there at that time was construction.

In terms of the animals that were present, again it was like another world. The composition of the benthic population was totally different than any we had previously observed. However, in the intertidal areas the presence of rock weeds, Littorina, and dog whelks was predictable even if the profuse growths of algae were not. Subtidally, it was totally different. Both the low species number and the species composition of the population were unexpected. Interestingly enough, the population diversity tended to change from Lorneville down the coast to Musquash. The number of recorded benthic organisms (excluding plants) gradually increased. There was also a change in the species distributions as we went along. From Taylor Peninsula going towards Saint John Harbour, we did not see any basket stars, scallops, or other organisms that one would expect to find in conditions which had sea water. Instead, we found predominately five species, one of them was Tubularia. This little hydroid normally grows in massive clumps but this summer it grew in enormous abundance. We were accustomed to seeing small clusters of Tubularia on weirs and wharves, but here Tubularia was unexpectedly one of the dominant species. Elsewhere, in the mouth of the bay, we were accustomed to seeing quite a variety of anemones of which Metridium was probably the most common.

Normally, in Deer Island or Grand Manan if you want to find a diversity of animals, you simply go to the bottom, find a nice rubble rock pile and roll one of the rocks over. Allan Logan can tell you, it can take

many months to identify all the species that are on the bottom of those rocks. In this area, when we examined the rocks, there was virtually nothing on the bottom of the rocks except Anomia, a little slipper shell which proved to be one of the dominant inhabitants. Another species that was new to us and grew in great abundance was a Bryozoan called Flustra. It is a sort of leafy animal that resembles a white hard plant growing on the bottom. It grew in great abundance down almost to Taylor's Point. We did not find it in our dives beyond that. Other species were present, of course, but in smaller numbers. We sat down recently and tried to compare what it looked like with some of the other areas of the bay. Passamaquoddy Bay shows a wide diversity of animals. The West Isles area is slightly better than Passamaquoddy Bay on our records. For the outer exposed coast which runs from the area around Black's Harbour to Point Lepreau, there appears to be a dropping off in diversity. Point Lepreau, itself, seems to fall into that same category. We now have data resulting from our current work for the New Brunswick Department of Fisheries, that will fill the gap in information about the area between Lorneville and the Saint John Harbour. One difficulty is that there is a progressive decline in the macrobenthos as you go along the coast. Unfortunately, we have no good data on the other side of Saint John, so we cannot currently tell if there is a natural progression as you proceed into the head of the bay, or if Saint John Harbour is impoverished in terms of the macrobenthos. As for St. Martin's, we did a little bit of work up there, but unfortunately there was no intertidal work done. The weather was terrible, and we did not get all the records that we wanted. Thus, St. Martin's may be higher, but in any event the trend is definitely there. As one progresses to Saint John Harbour (and from what Dave Wildish has said, as one progresses into Saint John Harbour), you will see a gradual dropping off.

That is the kind of information that we gathered at that particular time, and the way it seems to fit into the scheme of things. I do not know what conclusions to draw, except that there is a decrease in the diversity of animals as you proceed into Saint John Harbour with an increase in

abundance of those particular species. In the whole subtidal area, the ecological circumstances shift entirely around circumstances further down the coast. Sedimentation is high. At the time of our study we also observed some very unusual mortalities that bother me to no end. On the end of Taylor Point, we ran into fairly substantial numbers of common starfish, which were dying. They appeared to have a mould on them. The Coleson Cove area was the only place that Tubularia did not occur, and in that particular area there were hundreds of thousands of stocks or dead Tubularia. So, there were some events that made me wonder what was happening. Ecologically, there were other ways in which the area appeared different. Dog whelks, for example, were found 60, 70 and 80 feet subtidally. We had not seen this anywhere else in the Bay of Fundy. Sea urchins, instead of being enormously abundant as they were at Point Lepreau or any of the other areas, were relatively rare. You could find them with relative ease, and they were enormous. Our conclusion when we finished the work in 1973 was that this area appeared to be some sort of transition area.

Something was happening which was apparently related to sedimentation of the bottom. Lobster habitat, for example, was in very poor shape because of sedimentation. As I mentioned before, we observed in 100 feet of water just off Coleson Cove, a very substantial sedimentation site with very fine silt in it. The area off Musquash Harbour was very heavily sedimented, and we first started seeing some of the organisms that we were used to seeing down-shore; organisms like Brachiopods and scallops. I personally felt that a substantial sediment load was passing the Lorneville coast in 1974.

Fortunately, we were invited by Fisheries and Oceans to determine whether there were any apparent impacts from the thermal effluent at Coleson Cove. Now I can report that there were apparently no impacts. There were changes, but these cannot be related to the thermal effluent. It was just as cold two feet away from the thermal plume as it was down

the coast; most uncomfortable! In any event, some things had happened by the time we returned to resurvey the Coleson Cove area, from Tiner Point almost to Split Rock. In 1973 the Bryozoan (Flustra), that I mentioned earlier, was last recorded as being abundant somewhere around Tiner's Point. When we revisited the site it had moved down the shore into Coleson Cove and occurred in great abundance. Brachiopods, which I would view as one of the key indicators of high quality marine environment in 1973, were recorded as being abundant in Coleson Cove. When the survey was redone in 1980, no great abundance of Brachiopods was found. In the New Brunswick Department of Fisheries Resource Survey some were recorded, but again not in great abundance. Apparently Flustra had moved in, and Brachiopods and urchins had moved out. Anomia, another species mentioned before, was very uncommon in 1974 but by 1980 had moved down the coast to become part of the apparent Flustra complex. In addition, Halichondria, a bread sponge, was spotty in its occurrence in 1974 but was not recorded in abundance throughout the Coleson Cove area, and Mytilus which was previously recorded as common to abundant in Coleson Cove now seemed greatly reduced. The significance of these population changes is unclear. They may be related to heat, the use of biocides in cleaning out the tunnels for the Coleson Cove Generating Station, or they may be natural. It is interesting that the population of blue mussels was also reduced at the time this particular work was done.

In general, there has been a progression of new species into this area while some species have moved. The reason is unclear. I do not think that we have enough information to definitively say that the changes in species diversity are related to pollution from the harbour; I do not think that we can definitively say that they are related to increased sedimentation, although I believe that they are. Undoubtedly the degradation of this area is related to development, but I cannot say where the blame rests. It seems as if the port has been developing throughout its 200 year history. We are now somewhere in the middle of port development, and I think that is the crux of the situation. We could stand around and chew on numbers, but

I think that we have come to the point where we can act constructively. It is not too late. We are not at the peak: we have not totally eliminated the area; we have not totally eliminated the fishery. We are in the admirable position of being able to make changes in the near future whereas at many ports people have had to really work and go to a lot of expense to reverse their situations.

When you look at species distribution you see a great abundance of Flustra coming down to the mouth of the Musquash Harbour. You see two little spots of Flustra located down the coast, one at the mouth of Dipper Harbour and another near the mouth of Chance Harbour. In total, there are four species that are abundant in the Lorneville area and decrease to virtually nothing somewhere after Musquash. Figurus is common all along the coast, but is most abundant off the Lorneville coast. If you go down to the other end of the scale to what I am calling "clean dominants" (dominants that you would normally find in very clean, healthy ocean circumstances), you see Myxicola infundibulum, which is a little suspension feeding worm growing in a little tube; Hyas, which is a spider crab; Placopecten, the giant sea scallop; Boltenia ovifera, the big sea potato; and the Brachiopod. Myxicola drops off near Dipper Harbour; Hyas is quite common up the coast and begins to drop off and become very spotty as you get into Lorneville; scallops drop right off, with the exception possibly of a small bed that we discovered in 1973, right at the mouth of the Musquash; Boltenia ovifera disappears near the Lorneville coast; and the Brachiopod disappears near Coleson Cove.

I would say that there is definitely a transition of some sort, but whether or not it is a transition from the outer bay to the inner bay, or transition from the outer bay to the Saint John Harbour, I am not sure. However, I suspect that the sedimentation in the harbour and the general port development have affected the benthic fauna. It is impossible for me to reach any other conclusion, considering the level of port development. Whether I am wrong or right, is for someone else to decide; but,

nonetheless I believe there have been impacts on the benthic fauna in areas removed from Saint John Harbour.

QUESTIONS

Shankar Ray: How many years did you survey the transition, and what is your basis for comparison?

Art MacKay: From 1973 to the present. We returned to the same spot every time. In the Lorneville area we actually reran the original transects, which had about 30 stations over 300 feet.

Shankar Ray: And what about the other places? You are talking about the whole Fundy coast?

Art MacKay: The other places are, at one point in time, but the information that we have from Lorneville down to Point Lepreau is in a comparable period of time, within a year's time span or a year and a half. Thus, we can compare that whole stretch.

Dave Scarratt: What happens to the fauna as you go into the Musquash? Do you get a similar sort of situation going into Musquash as you do going higher up the bay?

Art MacKay: Yes, typically what we saw in all the embayments that we entered was a highly diverse subtidal benthic community on the edges, and the mud community lying up at the head which disappears somewhere in between. Musquash was essentially the same as any other embayment that we looked at further down the coast, except the species composition was slightly different.

Dave Scarratt: How far back do you go to be able to distinguish between macro transition and anthropogenic?

Art MacKay: That is tricky! In the New Brunswick natural history records, Ganong's records, the information of the local society of the Ladies Aid, reports by children of fantastic trips down to Courtenay Bay where they reported all the fantastic marine animals that were there - no one mentioned one species; so you can do nothing with it.

Dave Wildish: The point is, you have to do quantitative sampling to get that kind of information. I do not think the early naturalists did that.

Art MacKay: No, unfortunately that is probably true, but even some notations on abundance could be useful.

Mike Dadswell: Art, many of the things that you describe as appearing along the shore from the harbour to Musquash and on down are pretty typically estuarine, i.e., high abundance of certain species. Maybe you should clarify for everybody that when fresh water comes out of the Saint John River, it does go down the coast on the Lorneville side, and you have basically an estuarine condition occurring. It is important to some animals which are very susceptible to any fresh water or lowering of salinity. When you have a big flood in the spring like the Saint John does, you can kill your complete population until you have recolonization at another time of the year. You mentioned 1973, the first year you were there. That was the year of the 100 year flood, with the highest water and longest flood in the last 100 years, and the community out there could still be recovering from that single flood. You have to consider that.

Art MacKay: Fortunately, we did a series of temperature/salinity water quality profiles along that whole stretch of coast. Our data in no way indicated that there was any major fresh water influence in the deeper benthic fauna that we were looking at (and I am talking of at least 100

feet, where you can anticipate seeing pretty saline water in that particular area). Certainly our profiles taken at that particular time indicate that there is an influence in the upper area of the water, but there seems to be no influence at the depths that we were looking at.

I do not believe that the Lorneville coast is essentially estuarine. We have spent a lot of time in the St. Croix River estuary, which is much more an estuarine environment than the open water off Lorneville. The species composition in the St. Croix river is essentially impoverished, but taking on more of the characteristics of the other areas in the open bay. In other words, you may find Metridium in reduced numbers. All the normal species, present in every other estuary explored by us, are included there and tend only to be relatively few in number compared to numbers usually found in the Bay of Fundy. The factor that bothers me is the presence of some very strange species, not seen by me anywhere else in the Bay of Fundy, either on the Nova Scotia or the New Brunswick shores. These species are dominant, not typically estuarine and are typically suspension feeders.

My guess is that there are two types of animals feeding on suspended matter. One type would include organisms like sea peaches and sea potatoes which draw heavily on living plankton in the water. A second type would draw quite heavily on suspended organic matter. Can anyone suggest whether any of the species mentioned by me feed on suspended organic matter? If they do, then they clearly demonstrate increased sedimentation in the area. That is what bothers me about this estuarine overview. I agree with you that the influence of fresh water is there. It does not compare with any of the other work.

Audience: The other thing that you have to remember is that most oceanographers (Dr. Bezanson made a statement on this) claim the Bay of Fundy to be a large scale estuary. You are dealing with a circulation system that brings suspended sediments down along that shore from the upper

part of the bay from Cumberland Basin. Chignecto Bay complex is very highly turbid with very high natural organic levels. Until you extend your survey along the coast past the Saint John Harbour, I think you should be fairly careful with your statements as to what is causing the animals to be there.

Art MacKay: I simply said that a port, in the state of development of Saint John Harbour, must have an impact on the environment in which it is developing. I am not saying whether it is good or bad. If you are a fisherman it is bad, and if you are involved in port development it is good. There are numerous ramifications that have nothing to do with marine biology. I hope I made clear, I appreciate you mentioning this if I did not, that this is the state of the data we have now. This is where we have gone. There is an indication that there are changes as you proceed to Saint John and I agree with Mike before any definitive statements can be made, we need some sites on the other side of Saint John, preferably along a large stretch of coast. Nonetheless, there have been some progressive changes in the Lorneville area in the magnitude of a mile or so since 1973. The reason, I do not know.

SESSION III: The Fisheries Resource

Dave Scarratt - Session Chairman

Introduction

Recently, considerable concern has been raised with regard to the fishery. There has been concern expressed with regard to the loss of fish habitat and, in parallel, that there has been a decline in the fishery. To this end, one is quickly absorbed in fishery statistics, or lack of same; the question of over fishing; and the question of changes or complete loss of habitats. This session attempts to evaluate the information which is available to substantiate fishery changes. Many difficulties are apparent because much of the information is only circumstantial. With a lack of valid statistical information, changes to the fishery are very difficult to address scientifically.

3.1 Historical Changes in Saint John Fisheries

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Once you get into the archives and start digging back into the literature, you discover that there is a tremendous amount of available material on the history of Saint John. Much has been reviewed, but I think there is a wealth of information that we have not yet hit. The question is, "How do you synthesize it for presentation in contemporary terms?" We are right in the middle of a synthesis, so I would like to emphasize that what I will now say is qualified by our current state of knowledge and may change as we dig further into the literature.

The first topic that I would like to address is, "Historical port development and how it relates to the physical displacement of the fishery". In simple terms, the placing of each new structure in the harbour eliminates a little bit of fishery habitat. The second topic is, "The history of the port as it seems to relate to the fishery and the specific impacts that the port has had on the various types of fishery". This topic includes a discussion of the early lumbering industry, the chemical industry which is of increasing current concern, and the apparent changes in pollution levels. The third topic is, "A species by species assessment of the history of the fisheries for ground-fish, herring and others".

We have hunted through the literature and found a number of maps that help us find our way through the history of the development of Saint John. The first map we have was done by Ganong in 1761. From this map, my guess is that in Courtenay Bay in 1761 the environment was roughly similar to that of Musquash Harbour today. Courtenay Bay was probably a muddy

embayment with a mixture of rocky and muddy shores. The animals were probably mud-flat dwellers such as those at Musquash today. I suspect that good soft shelled clam beds existed there and were utilized by the early inhabitants in 1761. The area around Carleton, as far as we know, was a sort of marshy, mud-sand kind of environment probably with some rock, traversed by drainage streams. I expect that you would find the same sort of environment in localities where there was no port development. The whole area was probably a fairly healthy estuarine habitat. Nearby ponds probably contained fairly large numbers of Fundulus (killifish), sand shrimp, and other organisms accustomed to living in that situation. The sedimentation patterns and spits formed on the river, all tend to follow the expected pattern for an undisturbed river. Generally speaking, at the time of Ganong's map, the area was probably a very healthy environment with all the typical factors expected in this coastal area of the Bay of Fundy. The key areas are Carleton and Parrrtown; the two areas where major development has occurred.

Phenomenal changes occurred, between 1761 and 1848, in terms of the development of the city of Saint John. For example, the Portland Point area underwent rather extensive development. Historically, it was a typical inlet, probably with marsh plants and a mill pond area. However, by 1848, development along that eastern shore was fairly extensive. Weirs now appeared along the shore. Looking at some old photographs taken shortly after this period, I would say that the area was very heavily utilized by the fishing and shipping industries. In the Carleton area, the marine habitat was beginning to be utilized. The Rodney Wharf was being built. A number of other wharves began appearing on the scene, and a bridge was built across the whole thing. From our perusal of the documents, it is apparent that the fishing industry was still very active in this area. There are references to fishing lots being made available to various people on these shores, and to weirs being established on the shores in the inner harbour. The weirs were used for trapping salmon, gaspereau and shad as they went up the river. It seems that although the

fishing industry was utilizing the shores of the inner harbour, development was starting.

By about 1937, the major urban development across Saint John made it a major east coast city. In less than 100 years, the entire east bank had been developed. Now all the habitat that could have been utilized by the fishery for weirs had been used for wharves. There had been extensive development of Courtenay Bay, and the breakwater was complete. All the ship building facilities were present. The western bank was nearly completely developed. The only free land remained where the Harbour Bridge is now. By 1937, the fishing industry was practically excluded from the inner harbour, except for the fishery in the harbour itself. The shore had virtually been eliminated. Further down, the Reversing Falls Bridge had been constructed. There was a half-completed breakwater across to Partridge Island. A dumping ground showed up on the charts. In my mind, from 1848 to 1937, there was some major development.

I would like to suggest why there was a shift from an early emphasis on fishing to an industrial development complex in the inner harbour. First, this is the most logical thing that could have happened to a location on the east coast like this. It has all the prerequisites of a major port. It was settled early on because of these characteristics. During the early settlement period, it was fairly obvious that the fishing industry was one of the major key sources of income for the people involved. I think it was normal for the fisheries resources to be utilized by the people who settled the area early, and lived in the area. In the 1800's, some things began to change. The lumber industry became very important. In economic terms, the dollar value of the lumber industry started to outweigh the value of the fishing industry. So, all of the original fishing lots and wharves now became extremely valuable property for people who wanted to ship lumber products out of the port of Saint John. Apparently, the lumber industry started to overtake the fishing industry in the inner harbour. Gradually the emphasis shifted from shore

frontage for fisheries to forest product export. Simultaneously, there were other impacts on the fishery. The major impact came from the sawmills, located on virtually every creek. Along with the sawmills came the dams to operate them. That was probably the first step in eliminating the spawning habitat available to anadromous fish species. In fact, some of the streams out along the Mispic shore appear never to have recovered from the construction of sawmills at that particular time. There is every indication that the fish were eliminated from these local streams at about that time, and there is still no evidence that there has been any major rehabilitation of these streams.

A major problem accompanied this development of mills and the lumbering industry. All reports from this time mention the enormous quantities of sawdust entering the harbour. Now there were the first complaints about damage to Saint John Harbour. There was concern about the creation of mud and sawdust shoals in the harbour mouth, and the smothering of the normal marine habitat in the area. If you change the phrasing and the sawmills to something else, you will find we are saying exactly the same things today that were being said back in the the 1850's.

With regard to the fishing industry, there is a specific historical incident that I find totally fascinating. In the 1850's there was a conflict between the City Fathers and the fishermen. The fishermen complained at great length about the problems created by sawdust and about the general degraded state of the harbour in terms of junk lying around. The complaints were heard and the fishermen were told how right they were in these complaints. Certainly the fishing resources were well worth maintaining, but still why was there such heavy poaching and such disregard for the law? We have the same kind of situation now-a-days! Only the extent has changed.

The sequence of events began with the port being important to the fishing industry, then the lumbering industry and finally the

economically powerful industry that exists in Saint John Harbour today. Today, the value of industry outweighs the value of production from the local fisheries.

From 1937 to 1980, very extensive port developments occurred. For example, the Courtenay Bay Causeway appeared with the result that Courtenay Bay now has a perpetual dredging problem. The creators of the causeway have simply moved the beach; consequently, they have increased the shoaling in the area below the causeway. It is unlikely that, in future, Courtenay Bay will be cleaned out and will not need to be dredged again. Unless the whole dynamics of the bay change, and I can't see that happening, Courtenay Bay will be a perpetual cost to the industries located in Courtenay Bay. As well, the port facilities have been and are still being improved along the Portland Point area and the eastern shore of the harbour. The development and improvement of the port appear to be accelerating. In addition, the bridge has now been constructed. The Grandview Industrial Park and the complex are well on line. The industrial complex is not necessarily on the harbour, but it impacts on the harbour area. All of the effluents have to go somewhere, and at the moment they are going into the harbour. In addition, the development of these industrial centers is going to elevate the requirement for ship traffic. I don't have any figures on increases in vessel traffic in and out of the harbour, but there has undoubtedly been an increase.

The Partridge Island breakwater has been completed. More and more evidence indicates that the breakwater may be associated with a sedimentation problem on the Lorneville coast. This problem may be very important in relation to other areas along the coast. Other notable events include the relocation of the dumping ground, and the completion of both Canaport and Coleson Cove.

The impacts on the fishery through this period have been progressive. I believe, without a doubt, that the fishery has been physically excluded

from certain marine areas within the inner harbour, and is starting to be excluded in certain areas in the outer harbour. There has been a natural development of the port from an early beginning with a few fishing wharves, to its present status. Further development is possible on available land. I predict that the whole inner harbour will ultimately be excluded from the fishery. When the new breakwater developments take place, I predict that future sedimentation patterns will eliminate some fisheries such as the weir fishery formerly located near Partridge Island. However, some new grounds may be developed such as the good lobster fishing grounds near the rock debris resulting from the construction of the Canaport facility.

In terms of pollution - I would say that we are changing the context of our discussions. Originally, it was a physical sort of thing where there was sawdust and fecal matter floating around in the harbour. Our concern has now shifted to chemicals. Oil slicks are common but there has been an improvement regarding oil. I think that gradual control is being exerted, turning oil pollution into some sort of manageable problem. I think the problem now, in terms of pollution, stems from hidden chemicals within the water.

The groundfish fishery in the Saint John area was always important, and there are references to the importance of this fishery. Statistics concerning groundfish landings, and indeed all the fish, appear to be totally useless. There are so many over-riding factors when you look at landing statistics that it is difficult to relate any of these statistics to the potential or real value of fishing. The statistics are recorded at the landing port but the fish don't necessarily come from that particular area. Generally, there is a feeling that the groundfish population decreases as you proceed into Saint John Harbour. At one time, apparently groundfishing did occur in the harbour; however, there were apparently some restrictions on the inward movement of groundfish. During the summer there now appears to be some groundfishing available, but the markets generally preclude involvement in that fishery. It seems that the situation in

winter is different. There is a fairly good long-line fleet that comes up from Campobello and other places to fish this area in winter. We are getting very clear feedback from several people that they have switched, over the last 10 years, from fishing along the Lorneville coast to fishing offshore on the 50 to 55 fathom contour. As a matter of fact, they have gone so far offshore that they now have the option of docking in Saint John or Digby. They can go in either direction and my suspicion is that they prefer Digby as there are no facilities for the fishermen in Saint John.

As far as we know, herring weirs originally went clear into the Carleton-Parrrtown area but were gradually reduced to a cluster around the Partridge Island area. However, they disappeared somewhere around the 1950's apparently because of lack of fish. In recent years two weirs have been set up for herring and are doing quite well. Overall, there has been a general reduction in the type of cove suitable for shutting herring off. Among the losses are Courtenay Bay and all the little areas in the inner harbour in towards the Partridge Island breakwater. The seiners however appear to believe that there is no major difference in the size of the stock. With herring you are dealing with a non-resident species that can move in and out of the harbour. The seiners appear to have no problems, except for the numerous boats that they have to work around. They used to fish Courtenay Bay; however, some say that after the Canaport monobuoy was established the herring did not go there. As well, some allege that with the construction of petroleum storage tanks, the herring no longer went there. Now this I find intriguing because those big white tanks on the shore have lights on them, and herring are attracted by natural light but tend to be repelled by artificial light. Perhaps the lights on the storage tanks are keeping the herring away.

I will next briefly mention the salmon (1), shad and gaspereaux (2), lobster (3), scallop (4) and clam (5) fisheries. (1) Regarding the salmon fishery, nothing seems to have changed. In 1850, people were complaining about over-fishing, destruction of spawning ground, poaching, pollution

from mills, damming of rivers, and sawdust in the spawning grounds. As far as I can see, essentially nothing has changed. Salmon runs are still going on. I think the real impacts are going to be seen later in our life time, depending on how we respond to the needs of salmon. (2) Shad and gaspereaux appear to be little changed, although we see references to enormous quantities of shad and gasperaux being pumped out of the harbour. Possibly the numbers are reduced from the loss of spawning grounds up the river. (3) Lobsters might be affected by the possible impacts on the Lorneville shore from sedimentation, possibly related to the construction of the Partridge Island Causeway. (4) Only some small local scallop beds now exist. This may, again, be related to water and sedimentation. (5) Soft shelled clams are usually excluded from the fishery because they are polluted (based on coliform counts in them). Therefore, incidental soft shelled clam beds have been lost. These beds probably originally extended into the Courtenay Bay end of the river.

I will conclude by stating that there has been a displacement of the fishery, with the major portion occurring in the last ten years. There appears to be some fish habitat destruction. This is probably progressive as development occurs. The things to worry about in the future are chemicals. We must ensure that chemical effluents are controlled and studied to determine what their impacts will be, so that the impact of the developing industrial complex in Saint John will not influence the Bay of Fundy fishery. The impact will be localized and acceptable. I think we have to stop talking about whether there is a problem and say now how we are going to cooperate. Saint John Harbour is an industrial port. The question is how do we approach the problems that are related to the displacement of fisheries? What do we do for those people who wish to fish? My personal feeling is that Saint John has all the qualities to develop as a major international fish port, and it does not have to depend on the local fisheries. The fish port can become part of the industrial complex. The fishing industry and the people that are living here can become business partners. The problem is, "How can we bring this partnership about?"

3.2 Commercial Fisheries of the Saint John Harbour, 1875-1983:

Estuarine Fishes

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Abstract

Sturgeon, striped bass, shad, gaspereaux, eels, and Atlantic salmon are the major commercial estuarine and river fish species exploited in the Saint John Harbour. Annually, the Saint John Harbour produces about 60% of the New Brunswick catch of gaspereaux, 20-30% of the eels, 25% of the shad, and 5% of the salmon. Before 1973, the salmon fishery had the highest landed value, but closure of the fishery in 1973 and catch restrictions applied after its reopening in 1981 have reduced total value to the harbour fishery. Since 1973, gaspereaux because of large catch size, and eels because of high value per kg, have been the most valuable fisheries. Total value of the fishery for these species in 1977 was \$300,000. There were 331 licensed fishermen, of whom 5% were full time.

Introduction

Two different ecosystems support the Saint John Harbour fishery, the ocean on the one hand and the estuary and its rivers on the other; but the major fisheries have always been for the anadromous, river and estuarine species (Huntsman, 1952). A major reason for original settlement of the harbour area was that the Reversing Falls' complex acted as a mechanism for concentrating fish entering or leaving the river. In the past, when capture methods were less efficient, people were drawn to places where fish were abundant and easily accessible.

The Saint John Harbour and estuary annually produces about 60% of the total New Brunswick catch of gaspereaux, 20-30% of the eels, 25% of the shad, and 5% of the salmon. Total value of the fishery in 1977 was about \$300,000. There were 331 licensed fishermen, 5% of whom were full time.

The Saint John Estuary and Reversing Falls

The Saint John estuary forms a complex series of interconnected channels, bays, and lakes covering an area of 500 km² and extending inland from Reversing Falls on the Bay of Fundy, 120 km, to tide head at Fredericton (Figure 12). A combination of morphometric and hydrographic features, which control the occurrence and distribution of saline water in the estuary, results in a set of environmental conditions atypical for the region (Metcalf *et al.*, 1976).

The Reversing Falls sill, 5 m below the Bay of Fundy mean high-tide level, restricts circulation between the estuary and the bay and dampens tidal amplitude within the estuary. As a result, mean summer temperatures in the estuary average 9°C warmer than in the bay, vernal warming is rapid and surface temperatures can exceed 25°C in some years. Mean tidal amplitude inside the estuary is only 0.7 m as compared to 7.6 m for the bay (Trites, 1960; Metcalf *et al.*, 1976). There is more or less complete mixing of inflowing saline water with outflowing fresh or brackish water at Reversing Falls (Hachey, 1939) and the inland movement of this mixed water creates a zone of medium salinity (5-20 ‰) in the lower estuary (Metcalf *et al.*, 1976). During periods of reduced river discharge, an extensive zone of brackish water (0.1-3 ‰) forms in the upper estuary (Metcalf *et al.*, 1976). The warm, brackish regions of the estuary are highly productive (Gillis, 1974) and provide extensive nursery area for diadromous fishes.

The mechanism for ocean water entering, and river water leaving the estuary through Reversing Falls, is complex. There are two islands in the river just inland of the Falls and slightly to the left-hand side looking



Fig. 12 - The Saint John River and estuary indicating place names referred to in the text and statistical districts whose fisheries landings are associated with the Saint John Harbour.

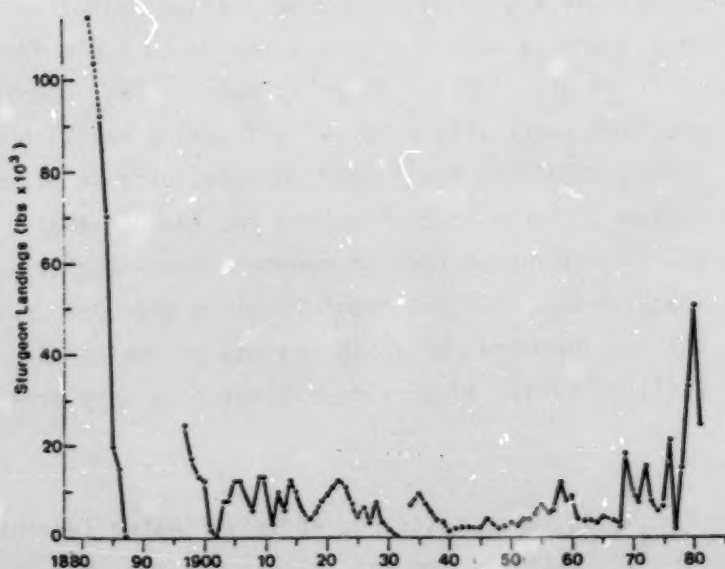


Fig. 13 - Sturgeon landings for the Saint John estuary since 1880. Fluctuation in catches since 1930 is largely a representation of fishing effort rather than stock size.

seaward. On falling tide, flow occurs seaward on both sides of the islands. As the tide rises, the river continues to dominate flow on the right-hand side of the islands causing the inflowing tide to enter on the left-hand side. The inflowing ocean water submerges immediately under the river water just upstream of the islands (Hachey, 1939). The outflowing, dark brown, murky river water occurs at the falls for two-thirds to three-quarters of the tide cycle. The 2-3 h of inward flow is green, clear ocean water and brings the anadromous fish into the river with it. Salmon jumping activity rises from almost nil on the falling and slack tide phases, to fish leaping almost every second during the inflow. Fortunately, for the anadromous fish, this method the tide has for entering the river has alleviated some of the problems caused by pollution from the city and the pulp mill situated on the right-hand side of the falls (Sprague, 1964).

The Fisheries

Some of the diadromous fishes are exploited in the harbour to a greater or lesser degree and some are not. Sturgeon and striped bass have traditionally been exploited in the estuary only, but some bycatch occurs in the harbour. The eel fishery takes place inside the estuary only. Gaspereaux are actively sought in the harbour early in the season (January-March), but the major fishery and catches occur in the lake-like backwaters of the estuary. Salmon and shad are actively sought both in the harbour and in the channels of the estuary, but the largest catches of these species occur in the harbour.

Sturgeon: Atlantic sturgeon (Acipenser oxyrhynchus) is the major commercial species of the Saint John River. Adults spawn in the middle to upper portions of the estuary and juvenile nurseries are concentrated in the lower estuary, particularly in Long Reach (Figure 12). Juveniles remain in the estuary for 5-7 years, at which time they are 3-4 feet in length. They then migrate to sea and feed on the Continental Shelf as far south as Virginia. When about 15 years old and from 50-100 pounds in

weight, they return to the river to spawn (Leim and Scott, 1966). After spawning they return to sea, but come back to the river every 3-5 years after for spawning. Individuals 35 years old and weighing 300 pounds are quite common in the Saint John River. The record for the river is 15 feet and 800 pounds (Leim and Scott, 1966).

Shortnose sturgeon (Acipenser brevirostrum) is the other species occurring in the river. This species is considered endangered in the United States, but the Saint John River has the largest known population (Dadswell, 1979). Shortnose sturgeon remain in the estuary for the duration of their life cycle. They are a small species, seldom exceeding 3 feet in length or 30 pounds in weight. Since the minimum commercially allowable size for sturgeon is 4 feet long, this species seldom enters the commercial catch. However, it has excellent caviar and could be utilized to some extent for this product (Dadswell, 1976 a).

Historical sturgeon landings of the Saint John River exhibit the boom and bust cycle common to most other North American sturgeon fisheries. A boom occurred as the virgin population was first exploited and a bust followed after overexploitation (Figure 13). A group of sturgeon fishermen from New York arrived on the Saint John River in 1880 and began the sturgeon fishery (Rogers, 1936). They caught 450,000 pounds in 1882, 280,000 in 1883, but only 16,000 in 1886 (Figure 13). That catch probably constituted close to the standing crop of Saint John River Atlantic sturgeon. From 1887 to 1895, the fishery ceased to exist because of lack of adult sturgeon. After 1895, the fishery recommenced at levels of about 12,000 per year, but by 1925 had declined to almost nothing. Little interest was shown for this fishery until 1975 when rising market demand stimulated activity. Since then, the number of fishermen has risen from one to five and landings from 6,000 pounds to 45,000 pounds per year. It will be interesting to see if the fishery can sustain the present yield. Sturgeon meat commands from \$1-\$2 per kg at present, and caviar about \$14 per kg. Although landings are small compared to other species, the value of sturgeon makes them worthwhile to fish.

Striped Bass: The striped bass (Morone saxatilis) is an anadromous species which spawns in rivers just above tidal influence (Leim and Scott, 1966). The Saint John River has its own spawning population (Dadswell, 1976 b) and is visited in summer by bass from United States populations (Figure 14). Juvenile bass live in the upper estuary; adults live at the outflows of the lake systems and concentrate around the Reversing Falls in summer (Figure 15). Saint John River striped bass reach 3 feet in length and 50 pounds in weight and can live 30-40 years (Dadswell, 1976 b). They supported both a sports and commercial fishery in the Saint John River.

The commercial fishery was concentrated in Belleisle Bay (Figure 12), the major overwintering site for bass in the estuary (Figure 15; Williamson, 1974). The season was from December 1 to March 31. Fixed gillnets, with a minimum mesh size of 13 cm stretched, were used. Nets were set under the ice with the aid of an ice jig in depths of 10-30 m. In 1977, the commercial bass fishery was closed for a 10 year period to allow the stock to rebuild.

Recorded landings between 1875 and 1975 exhibit large oscillations in catch per year with high landings occurring on about a 9-11 year cycle (Figure 16). Bass are known to have very cyclic levels of abundance (Merriman, 1941) and that could be a partial cause for the variable landings. However, discussions with older fishermen indicate part of the cyclic nature of the Saint John River landings is due to variable fishing effort. The Belleisle Bay winter fishery was not established until the 1930's and low catches before that time, except for the high catches in 1885-1888 concurrent with sturgeon exploitation, may be due to low effort. The last period of high landings recorded between 1959 and 1970 was partially an artifact of increased exploitation by one fisherman in Belleisle Bay using boats before ice-up, but it also could have resulted partially from the higher than average temperatures in Atlantic Canada during the early 1950's (Lauzier, 1965), which may have increased survival and production of bass.

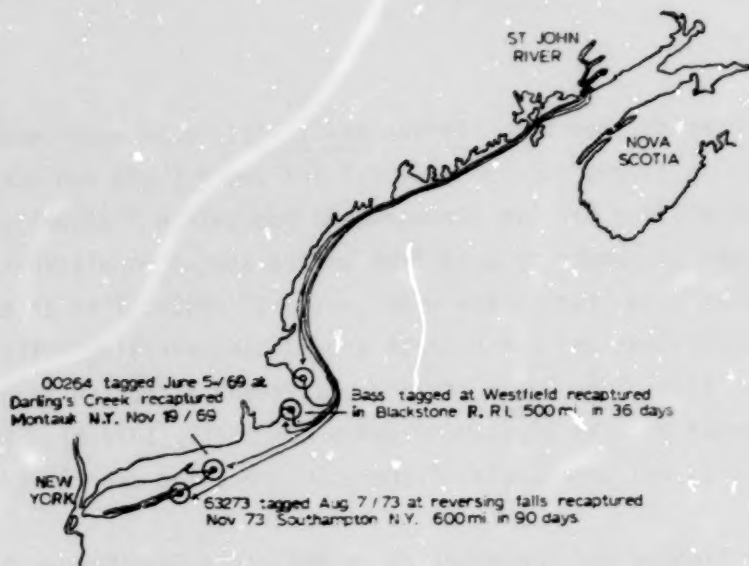


Fig. 14 - Movements of striped bass tagged in the Saint John estuary along the Atlantic coast.

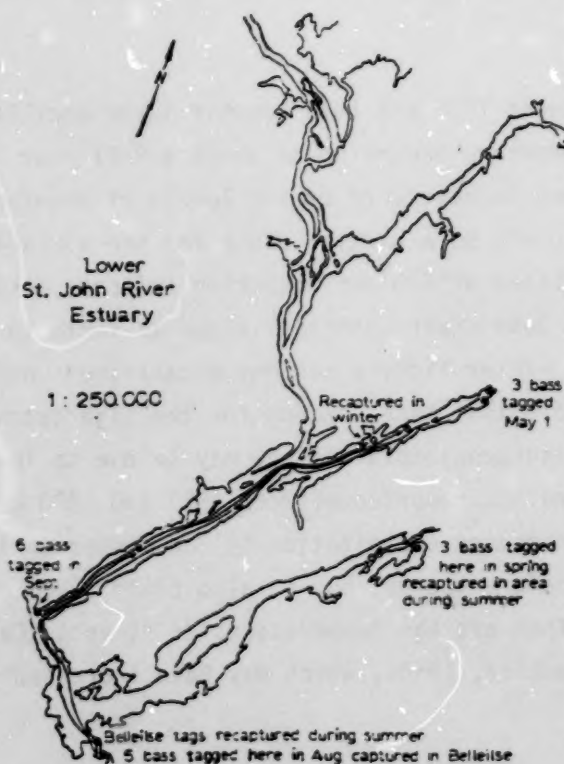


Fig. 15 - Movements of striped bass tagged during spawning runs in the upper estuary and at Reversing Falls during summer.

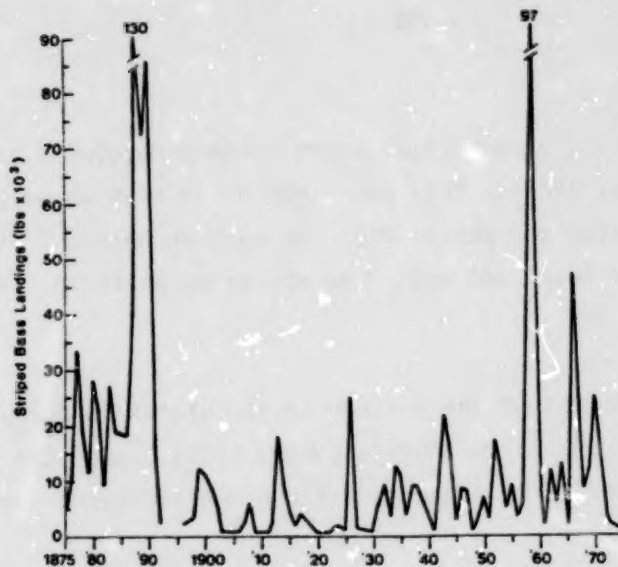


Fig. 16 - Striped bass landings for the Saint John Estuary; 1875 to 1975.

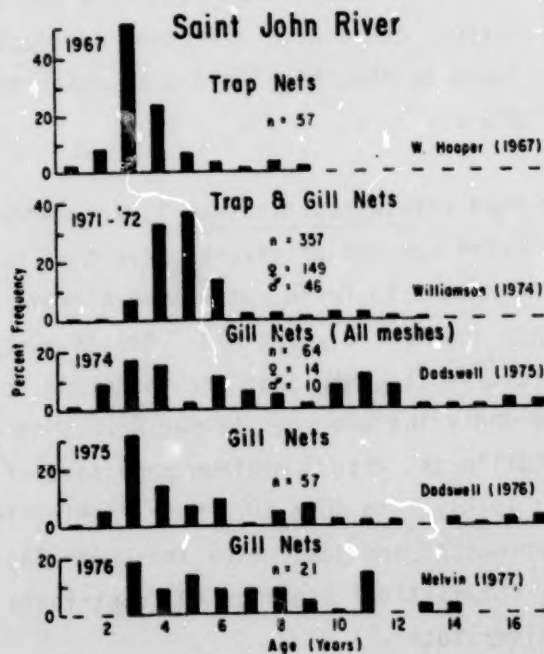


Fig. 17 - Catch and age structure of striped bass in the Saint John River (1967-1976) by various researchers using trap nets and gill nets of mesh sizes from 5 cm-25 cm stretched.

Between 1950 and 1965, an excellent sport fishery developed on the Saint John River (Hooper, 1967). This was a period of high abundance for the population and was also the period when the eastern United States population was at a high level and bass were migrating north in large numbers.

Fishermen came from most of the eastern United States in pursuit of bass with the resulting benefit to tourism (Meth, 1972). When the populations declined after 1970, numbers of fishermen decreased similarly.

Reasons for the decline of the Saint John River bass population were not established. Lack of strong year classes entering the fishery were manifest by 1971-72 and the situation was unchanged through 1977 (Figure 17). Population decline could have been the result of low average annual temperatures after 1955 (Lauzier, 1965), decreasing reproductive success, the normal cyclic nature of bass populations, or overexploitation which reduced adult stock size. It is also possible that pesticide applications for spruce budworm, or PCB pollution, could have affected reproductive success since adult bass were found to have high levels of chlorinated biphenyl residues (Dadswell, 1976 c).

American Shad: American shad (Alosa sapidissima) is an anadromous clupeid which spawns in slow moving regions of rivers above tide head. Juveniles spend their first 3-4 months in fresh water then migrate to sea. Adults return to spawn when they are 4 or 5 years old. Adults average 3-5 pounds in weight and reach 2 feet in length. Shad are in demand for both their flesh and roe. Their landed value averages \$1 per kg. Shad are captured with drift and fixed gillnets, with a minimum mesh size of 13 cm stretched allowed. The season is May 1 to June 10. Most fishing is concentrated in the harbour approaches and just below the Reversing Falls, and landings from this fishery (Statistical District 49) contribute about 75% of the annual Saint John River total.

Saint John River shad landings during the last 100 years demonstrate two cycles of high and two cycles of low abundance with an approximate 30 year phase between peaks or depressions (Figure 18). At present, we are 20 years into a low cycle and landings may improve by 1990. Landings during the 1950's were the highest ever recorded and peaked at 1,000,000 pounds in 1953.

There are both problems and good prospects for the shad fishery in the harbour. The construction of Mactaquac Dam in 1967 virtually eliminated a known run of 40,000 adults that spawned above the dam site (Jessop, 1975). The permanent loss to the fishery may represent 150,000 pounds, more or less, per year. Since 1981, surveys of fall-run shad in the Saint John Harbour (Bradford, 1981; Bradford et al., 1982) indicate large numbers of shad, originating from rivers in the United States, occur there August through October after feeding during summer in the upper Bay of Fundy (Dadswell et al., 1983). The information suggests a profitable fall shad fishery could be reinstated in the harbour without harm to the local Saint John shad stock. The former fall shad fishery in the harbour was closed during the 1960's.

Gaspereaux: The fish grouped as gaspereaux in the commercial fisheries landings statistics actually represent two species - the alewife (Alosa pseudoharengus) and the blueback herring (Alosa aestivalis). They both spawn in fresh water, the former in lakes or lake-like portions of rivers, the latter in rapids or fast running water. The juveniles remain in the estuary for the first summer then migrate to sea. Adults return to fresh water after 3 or 4 years of age at about 1 foot in length and 1/2 to 1 pound in weight (Messieh, 1977). They are caught in the harbour and lower estuary with fixed gillnets of 8 cm minimum mesh size stretched. In the upper estuary, the fishery is conducted in backwater areas using large pound or trap nets. The harbour and lower estuary fishery begins in January. Gaspereaux are captured in the harbour and under the ice of the lower estuary. At this time, they are mostly shipped to southwest Nova

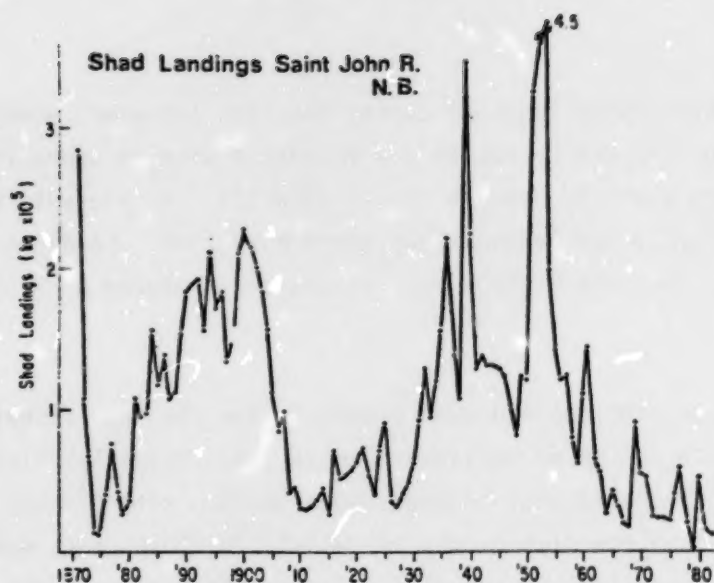


Fig. 18 - Landings of American shad in the Saint John River and Harbour since 1870.

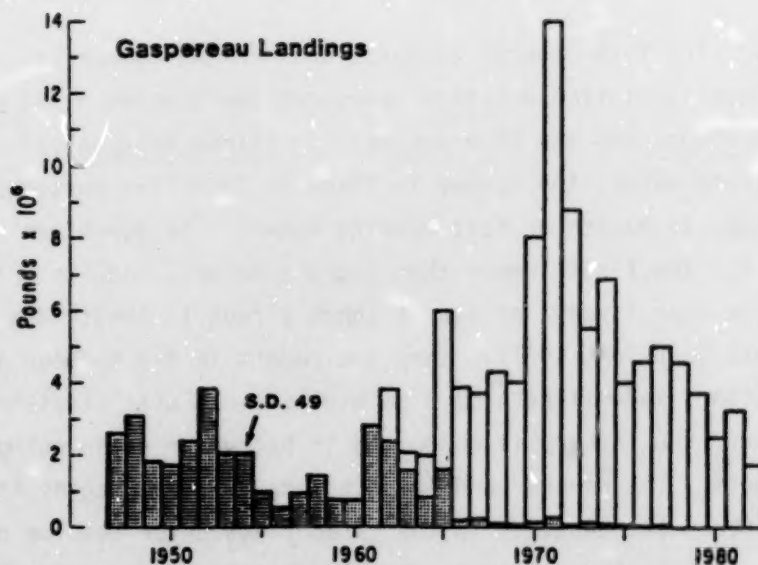


Fig. 19 - Gaspereau landings in the Saint John Harbour and Estuary; 1947 to 1982.

Scotia for lobster bait and the fishermen obtain up to 30 cents per pound. After May 1, the main fishery is concentrated in the upper estuary (Belleisle Bay, Washademoak and Grand Lakes) where the major catches are taken. During the spring fishery, fishermen receive only 1 cent per pound for gaspereaux.

Before 1960, the majority of gaspereaux landings occurred in the harbour. They averaged from 3,000,000 to 6,000,000 pounds per year (Figure 19; Rodgers, 1936). From 1875 to 1920, the estuary catch seldom exceeded 2,000,000 pounds and between 1920 and 1960 was almost nil. After 1960, the estuary pound fishery began and landings climbed rapidly to peak at 14,000,000 pounds in 1971 (Figure 19). The decline in harbour landings after 1965 must be related to reduced effort for gaspereaux since they were obviously still plentiful. An event leading to an increase in the gaspereaux fishery was the filling of Mactaquac reservoir. Gaspereaux runs to the dam increased from 200,000 to 8,000,000 individuals in 7 years (Jessop, pers. comm.). Landings at the dam are now 500,000 pounds annually. A sharp decline in landings occurred in 1980-1982 (Figure 19). A similar decline also occurred in most other gaspereaux fisheries along the Atlantic coast and it could possibly be related to climatic causes.

Eels: The American eel (Anguilla rostrata) is a catadromous fish which lives and grows to maturity in fresh water then migrates to sea for spawning. Larvae return to the river after drifting at sea for 1 year (Leim and Scott, 1966). Growth to maturity takes 7 to 10 years. Large eels are 3 feet long and weigh 1-2 pounds. The fishery is conducted in weedy, shallow backwater regions of the estuary using submerged trap nets or baited eel pots with 2.5 cm stretched mesh.

Eels were virtually unexploited in the Saint John River prior to 1960. During the 1970's, catches increased dramatically (Figure 20) because of increased market demand and a shift of fishermen from northern New Brunswick rivers to the Saint John River. Since 1970, landings have

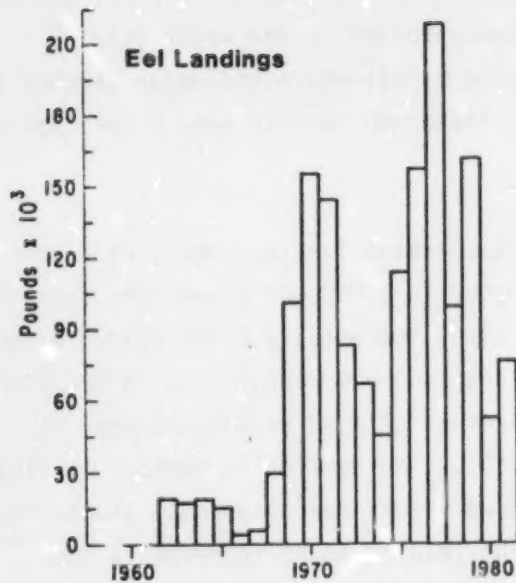


Fig. 20 - Eel landings for the Saint John Estuary; 1962 to 1982.

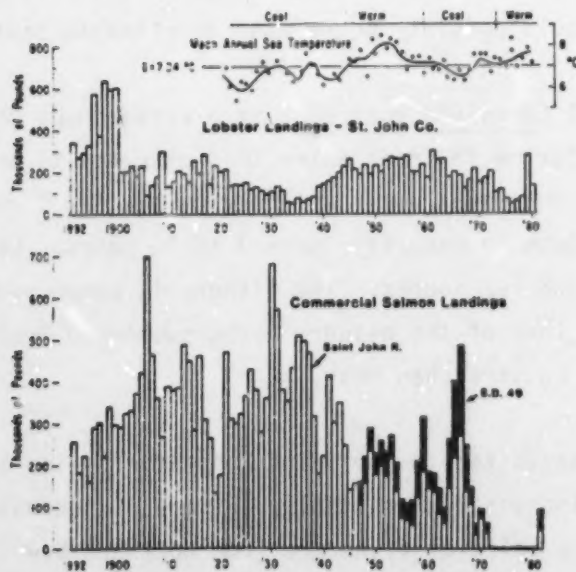


Fig. 21 - Salmon landings (bottom) for the Saint John River and statistical district 49 and lobster landings for Saint John County. Lobster landings are in phase with warming trends (lagged approx. 10 yr) and salmon landings are in phase with cooling trends.

oscillated around 120,000 pounds per year (Figure 20). Eels are worth between 60 cents to \$1 per pound and have often been the most valuable Saint John commercial fishery during the last 10 years. Since eels have a long life span, it is yet too early to observe whether the increased exploitation of the 1970's will cause reductions in the future eel landings.

Atlantic Salmon: The Atlantic salmon (Salmo salar) is an anadromous fish that spawns in all accessible portions of the rivers flowing into the Saint John estuary (Meth, 1972). Juveniles remain in fresh water for 2-3 years then migrate to sea, to return 1 or 2 years later at 2-3 feet in length and 4-20 pounds in weight. The commercial fishery is conducted with fixed or drift gillnets in the harbour and trap nets in the estuary. Minimum allowed mesh size is 13 cm stretched. The commercial fishery was closed in 1972 because of low stock size and reopened in 1981. Before 1972, there was no restriction on commercial catch per fisherman and the season was from June 15 to August 30. Since 1981, the fishery is allowed between July 1-30 and an individual fisherman is restricted to a quota of 70 salmon (9-15+ pounds) and 150 grilse (3-5 pounds).

Saint John River salmon landings averaged 300,000-400,000 pounds per year from 1895-1965 with approximate 30 year cycles of higher and lower yields (Figure 21). Superimposed on the long term cycles are 5 year cycles of greater and lesser yields. The high cycles are in phase with periods of cooler, wetter weather, and this fishery is cycling opposite to the cyclic phase of the striped bass (Figure 16), shad (Figure 18), and lobster (Figure 21). The latter species all require warmer average summer temperatures to increase production in the Bay of Fundy region (Dow, 1969). During the late 1960's, there was a period of extreme dry, hot summers, which may have been a major cause for the lowest salmon landings on record in 1969-1971. After 1950, there did appear, however, to be a major decline in the productivity of the salmon run (Figure 22). This general decline may have resulted from the combined impact of the budworm spray program and

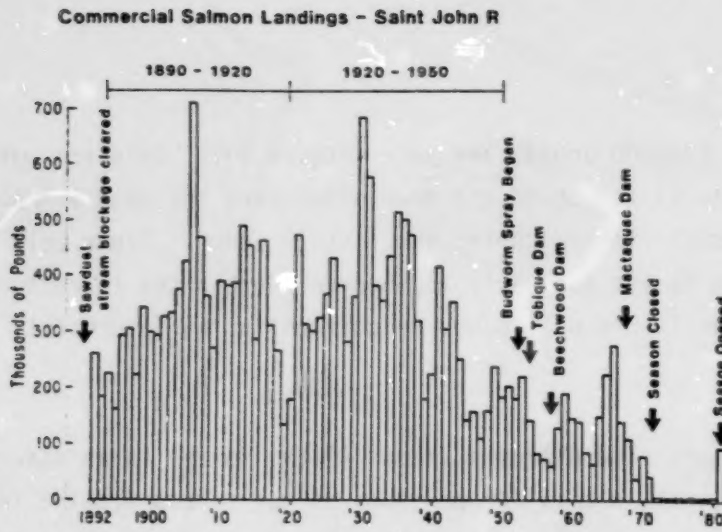


Fig. 22 - Saint John River salmon landings and periods of first impact by human projects.

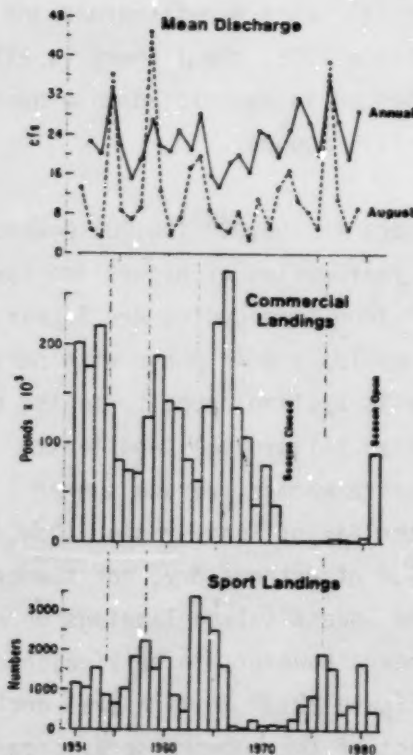


Fig. 23 - Mean annual and mean August discharge of the Saint John River and commercial and sports Atlantic salmon catches in the same year; 1951 to 1981.

the loss of parr habitat associated with the construction of the Tobique, Beechwood and Mactaquac Dams. It may also have been due to the take of Saint John salmon in the Greenland fishery. Two year classes of parr (1952, 1953) were decimated by use of DDT (Elson, 1967), which resulted in sharply decreased landings in 1955-1957.

Salmon runs are strongly influenced by water levels on both a short and long term basis (Scarnecchia, 1981; Gee and Radford, 1982). Water levels in a given summer can lead to good catches by either commercial or sports fishermen and lead to perceived salmon levels of abundance regardless of their actual, true abundance. High mean discharge during August usually adversely affects the harbour's commercial fishery because it causes the salmon to move through the harbour rapidly and reduces catches (Figure 23). High flows generally have the reverse effect on sport fisheries because water levels remain up and the salmon take well (Figure 23). Low August flows have the reverse effect and when concurrent with the peak of the 5-year abundance cycle (i.e., 1966) result in large commercial catches (Figure 23).

Actual size of a salmon run, on the other hand, appears to be most closely related to mean annual discharge during the 0+ year class (Scarnecchia, 1981). Periods of high average discharge (1958-63) lead to high salmon landings after a lag period of 6 years (1964-68) (Figure 24). Because annual discharge has been increasing since a low in 1965, salmon landings should improve through to 1985-86.

In summary, it can perhaps be predicted that the harbour and estuary fishery will remain at lower than traditional yield for the near future. Salmon landings will remain low (probably less than 100,000 pounds) because of the quota restrictions. Shad landings will probably not increase until the 1990's. Eels, gaspereaux and sturgeon may hold at present levels or decline a little, but it will be after 1985 before we will see if the increased exploitation of these species during the 1970's was above a sustainable level.

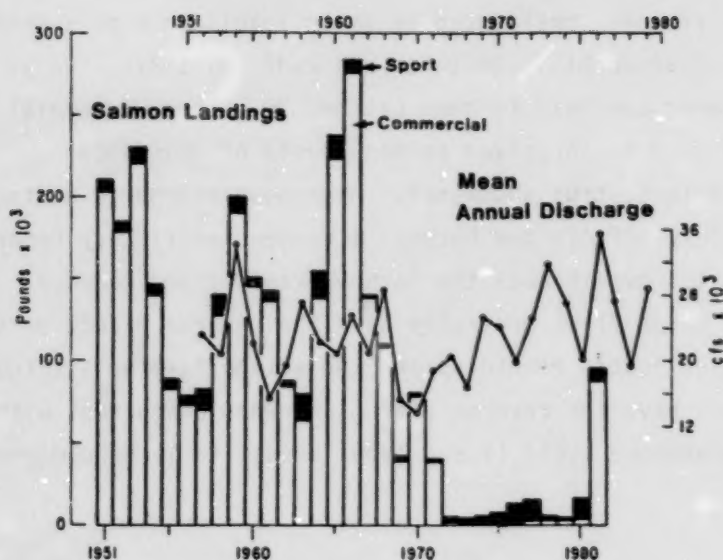


Fig. 24 - Total Atlantic salmon landings in relation to mean annual discharge lagged 6 yr (e.g., high flows 1958-1963 result in high landings, 1965-1968).

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QUESTIONS

Bev Bacon: Mike, with respect to the phasing of the salmon fishery and the lobster fishery: how much of that increased action in the alternate fishery might be due to the fact that, for instance, it is a poor year for salmon so the fishermen take their effort and put it into lobsters, so you have the same men which would give you an extra little bump in your graph in terms of effort?

Mike Dadswell: Well, I could be a little wrong here, but the lobster season is almost the opposite from the salmon season and most people who lived in the harbour and had a lobster license fished salmon, and vice versa. Thus, you do not have that effect really. I think the effects you see in the statistics are real, that those big runs are really big runs, with the accumulative effect of 5 and 30 year cycles of rainfall, warming or cooling on top of that, along with a good escapement in a particular year.

Leonard Wilson: I see that you have pretty well documented the migration of fish in the river, streams and harbours, but you never do tell us what happens to them when they go to sea. What mortality takes place on the high seas when they are there? This is the question that I have been asking for 20 years; I have not yet got an answer!

Mike Dadswell: Well, what species do you want to know about?

Leonard Wilson: Salmon, shad, gaspereaux, everything.

Dave Scarratt: I think we should try to concentrate on the local area. I realize that there are things outside the area over which we do not have much control, but for the moment we should probably focus on the river and the bay.

Leonard Wilson: If you do not have any information on what takes place, how do you know what migration patterns you are going to have coming back? We may raise them here, and send them to sea, but if someone takes them at sea - some foreign fleet - we are going to have no fish coming back. This is something on which there is no data. The Atlantic Salmon Board has argued about this for days and days and we cannot get any answers.

Mike Dadswell: Well, for most of the landings that are seen for salmon prior to 1960, there was no high seas fishery, so that is real. That may be why the run got cut down. In the 50's you had all the problems with the river at the same time; thus, the things may have just added to each other.

Audience: Salmon from our rivers do not migrate to the Greenland fishery?

Mike Dadswell: They did retrieve tags from Saint John River salmon in the Greenland fishery, but not from the Miramichi and the Restigouche River salmon stocks.

Leonard Wilson: As far as I can find out, you have 12 tags out of 700,000, so I would say that is not very many fish.

Mike Dadswell: No, I agree with you, but the thing is that we do not know precisely what is going on out in the high seas. There could be a Russian drift fishery off the Flemish Cap, for example.

Leonard Wilson: That is certainly going to have a great affect on your figures.

Mike Dadswell: I doubt it.

David Thompson: I would just like to make a few comments, and maybe ask a question about some of your last comments about the lobster fishery in the last couple of years. As someone who has been standing on the ends of most

of the wharves and aboard the boats, I have observed that it has been particularly poor during the last three years; I think that Len Wilson can attest to that. In fact, it has been worse in the last couple of years than it has been for many, many, many years.

Mike Dadswell: Now qualify "it". Where?

David Thompson: All over Saint John County, except for that portion of the area (not this season gone by, but the previous season) which was good in the area around and above St. Martins. Now, if that particular area is lumped in with the area that is being affected by all these environmental factors around Saint John Harbour and west of Point LePreau, it will distort it. I think a lot of people here found your talk interesting, but to me your analysis is full of holes. The last two years have been a disaster for lobsters.

Mike Dadswell: If you look at the statistics down the whole Bay of Fundy, every county from Charlotte County, and down into Maine, all have shown increases in landings in the last two years. How do you explain that, when you come and say that from where you were standing the landings were poor. Statistics for all the counties are showing increases.

Dave Scarratt: I think this goes back to the very first point that Art made, which is notwithstanding the fact that the statistics that we have are the best and the only ones that we have. There is still, nevertheless, considerable room for disagreement between what the statistics say and what the fishermen say. I think this is a paradox which we may have to live with and continue to live with. The statistics may show that there has been an improvement; the fishermen may continue to claim that, in fact, life is worse. I cannot answer that, and I am not certain that anyone can.

Art MacKay: Can I comment on that? I was like Dave. I was intrigued by the trends and so on. I am wondering if it is not a question of magnitude.

Peaks are perhaps higher because of these factors and valleys lower, but it would strike me that we might have 25% error and still not change the trend that has been demonstrated.

Mike Dadswell: I would say that most statistics underestimate what has been caught by a considerable amount.

Paul Mawhinney: About three years ago we recorded statistics in District 48. We had to report the place of fish caught; then we switched it to place of fish bought, and now we are back to place of fish caught. If you take the whole area together, you will find that District 48 landings have been up. As for St. Martins, all the fish caught in the Martin Head area, which is a large fishery, are recorded as a St. Martins fishery because there is no landing port locally. So that puts St. Martins up. The whole thing comes down to the whole catch taken all together.

Mike Dadswell: I realize that. I know Beaver Harbour and Campobello lobster fishermen are fishing Alma early in the season and they are landing their catches in Campobello. What I am saying is that you have to look at this over a long section of coast, and then look at things that happened in the past when maybe people were not paying as much attention to this, and you see the same kind of trends now based on the same kind of physical actions that take place. Really, as Art has said, things really have not changed.

2. PANEL DISCUSSIONS

SESSION IV: Implications and Interactions

Peter Eaton - Session Chairman

Introduction

The interaction which dominated discussion in this session, and which seems to draw the greatest attention from fishermen and scientists alike, is the struggle between the fishing industry and the reduction of environmental quality. On the one hand the fishing industry, which has experienced a long prosperous history in the Saint John area, is experiencing accelerating declines in success, particularly during the past 10-20 years. These declines are well documented by numerous observations and subjective evaluations by fishermen, but with only scanty "hard" data being provided by the scientists. On the other hand is the progressive and inexorable development of the Port of Saint John, which has responded over time to the shifting emphasis from a fishing port to a large import/export facility, with all the activities that this involves such as dredging, wharf construction, breakwater construction, numerous service facilities for shipping, and the inevitable degradation of environmental quality.

The major question which essentially remains unanswered was, "What is actually causing the decline in the fishery?". Arguments ranged from sewage disposal, to siltation, to overfishing, to overlapping regulations on salmon and other stocks. Observations of silting of fishing grounds were described as far south as Lorneville, however, the scientists were unable to provide a sound basis for the apparent increasing siltation in the bay. Work in St. Andrews was presented as evidence that heavy metal levels resulting from dredged material disposal are unlikely to be a significant factor in the decline of the fishery. In view of the inability of scientists to answer this question, considerable support was given to

improving the scientific basis for assessing the problem, in particular, to the use of physical and numerical models. Although some good data exists on currents, sediments, contaminants and fisheries, it was accepted that, because of the extremely complex and dynamic nature of the hydrology of Saint John Harbour and the Bay of Fundy, much more data will be necessary to understand exactly what is going on.

Long term planning, in the context of coastal zone planning, was seen as an essential element of interaction amongst industry; municipal, provincial and federal governments; and the public, in order to ameliorate impacts resulting in decreased environmental quality. In this way environmental concerns could be brought to bear on development which could then advance in a positive way with a minimum of disruption to natural resources. The Environmental Assessment and Review Process (EARP) can be seen as attempting to achieve this in the case of major developments. Minor changes or increments, however, are often missed by this process and can eventually add up to substantial changes with an equally substantial impact on the environment. Comprehensive planning was suggested as a way around this problem.

It was generally concluded that it is necessary to look at the total social picture when considering the impact of development, and that care must be taken when examining the cost of one thing versus the benefit to another. Financial considerations must not be the only basis for decision making. The Musquash Harbour proposal was used as a case in point where extensive potential environmental damage must be weighed against alternatives such as the use of existing facilities. It must be decided whether to allow the progressive loss of the fishery or to manage things for the best of both worlds. Obviously it is impossible to maximize for more than one variable (e.g., environmental quality and industrial development), but it is possible to optimize.

Peter Eaton: I am going to ask each of the four panel members to briefly mention some of the points or some of the ideas that have come out of listening to the talks and relate some of these points to their own specialties.

Don Bezanson: Well, from the bits and pieces that I have heard from other people's talks (Art's talk in particular), it seems reasonably clear that the physical effects of man's activity in the harbour, perhaps even more so up the river from the harbour, have had an effect on fish stocks and landings. I think the question to consider at this point is, "In what ways could the physical situation be improved?" I think it is perhaps better to consider improving the situation from this point onwards than to spend too much time trying to stop things that are going to happen anyway. I think perhaps we could be thinking about and trying to influence developments in a positive way.

Art MacKay: Basically I agree with Don. I think that in Saint John we have a developing harbour. We know what has happened around the world, where rivers like the Thames have been subjected to massive cleanups. I think that in the case of Saint John Harbour we have the advantage of our point in time. We know, in terms of resources and industry, the long term consequences of not controlling the methodology of development so that you get the maximum from that development. I think it is time to stop, become positive, and realize that there is the possibility of having major industrial expansion hand in hand with the fishing industry. We should use this cooperative approach now - before the problem becomes so horrendous that it is impossible to solve certain components of it. The Saint John fishery will never again be the way it was originally, and there is a real challenge there for the City, the federal Department of Fisheries and Oceans, and others concerned, to maximize Saint John's potential as a fishing port. I do not know what the context would be, whether the offshore fishery or the local fishery, but I think it is time that everybody stopped trying to define and study the problem and started

looking for solutions - ways to continue in the future in which we would not have a net loss, either economically or in terms of people's lives but a net gain, both from the renewable resources in the bay and the industrial development in Saint John.

Allan Fiander: We have recently done some work concerning the requirements for commercial fishery and recreation in the Saint John and other harbours along the Bay of Fundy coast. Now we are working on a variety of other projects related to port development. This is the area of concern that I would like to emphasize. The participants in discussions in the past one and one-half days are essentially experts in various topics related to environmental questions. My work is directly involved in attempting to develop facilities. During this development we must be cognizant of the implications from an environmental point of view. Over the past few years, we have been working more and more closely with environmental experts; many of whom are in this room. Now we are attempting to develop a master plan for the future development of the ports of Dalhousie and Belledune, in a similar manner to that which has been done and discussed yesterday for Saint John. A variety of factors must be considered - not only the requirements for the port facilities, or the demand associated with those port facilities, but the constraints on development and on future plans because of environmental factors. For example, the project on Dalhousie and Belledune has been effectively postponed for approximately a year pending the results of some work relating to the disposition of dredging spoils, etc.

I noticed that yesterday when the current master plan of Saint John was presented, there was some question about Musquash Harbour and the potential conflict there. There has also been a variety of questions raised concerning the general level of sediment transport and its effect on the harbour areas and fishery. Essentially, the many questions raised over the past couple of days emphasize the need for ongoing cooperation and coordination of everyone involved in development of port related

facilities. Again, comparing Saint John with Dalhousie and Belledune, the environmental impact in the latter ports is perhaps more direct and noticeable. However, in Saint John, the immediate impact may not be as great, but it is still there. My understanding of the plan for Musquash is that there are many events scheduled to happen prior to development there. That is a relatively long term matter, but I think it is very important that a sort of dialogue, and the work that will evolve from it, be conducted quickly. We would certainly be unwise to leave all these matters until they become supercritical in the scheduling of things.

Bill Ayer: I think that many of the comments made at this workshop are heading towards some form of comprehensive planning of future harbour happenings. One phenomenon that I have seen as an environmentalist is incrementalism, and the problems that come trying to cope with incrementalism. Each of these developments is an increment, and the smaller the increment the harder it is to manage, because in the regulatory sense someone has a small amount of something being added and they will say, well that is not very much. It is only this much. So as a regulator, you are in one hell of a position trying to say, "We should not do this". However, as time has progressed we probably have seen these increments growing larger and more comprehensive. The larger the development, the larger that increment. People, however, have now begun to realize that as these increments are added one to another, the environmental impacts (the assimilation capacity if you will) of what is out there are getting narrower and narrower so that each increment has a greater impact.

We are beginning to find ourselves more and more constrained, and the pressures are getting greater and greater to do something with this problem. Prior to this, you have been able to get away with adding increments without any planning context; it has just been one increment after another. The impacts on various uses, the externalities, have been there, but we really have not put them in any context. It has been a haphazard or random type of development. Then along came the larger

developments, and an environmental impact process that looks at the larger more comprehensive ones, and tries to do planning in the back door. It tries to do the planning that should have been done all along. One of the things environmental impact statements do is that they eliminate the minor issues and look at major ones; thus, they in fact avoid the increments again. Unless you have a planning context that can take into consideration a number of things, you are going to miss the boat in the long term. I would emphasize, in a harbour context, the master plan approach is essential. However, it has to be continual and there must be some feedback for the process, and effective monitoring. First you must set some limits for the various uses, then there has to be monitoring to see if those limits are being met, and feedback into the planning process to keep the whole process continuing down the line in some intelligent and progressive fashion. The other thing is, if we fail to do the planning, the public controversy with each increment is going to be greater and greater as you get closer to the limit of that assimilative capacity of the environment, or a step over it.

I would say that large projects in the future, and I think this comes partly from the impact experience that I have had with the Department of the Environment, will become more and more controversial because people are beginning to realize that the assimilation capacity is no longer there, and they are beginning to want to know what those things are going to do. Thus, I would say that we need a planning process and effective input to that process. We know very little about the receptors. We try to make decisions in vacuums like what we know here about the biological conditions out in the harbour. I have not seen anything on the uptake of metals in organisms. I do not know if there has been work done there. I have not seen anything, but to me that is important.

The last point - it would seem that we have made some efforts on water quality objectives for the Saint John River, for the international portion between the United States and Canada, for setting up some sort of limits to

which we want to see various uses protected. The uses are translated into numbers, and although it is recognized that you cannot always meet those numbers, at least it is a receptor understanding that we have had to make. In the marine environment along the coast, I feel that there should be some sort of receptor understanding and some limits set that can be used in managerial decisions.

DISCUSSION

Leonard Wilson: I understand that 400,000 to 500,000 people a year may go through the Market Square Complex, when all events including conventions and other major functions are considered. We want to know where the sewage is going. Are they going to dump it into the Saint John Harbour along with the rest? I assume that the Department of the Environment or the City Planners should know what is going to be done with it!

Peter Eaton: This is one of the problems that Bill was referring to. There is considerable difficulty in combining small continuous increments with long term planning. It seems that the large scale plans for Saint John are fairly well advanced, but it is a lot of the small scale developments that could create problems.

Leonard Wilson: This also should be of interest to the Department of Fisheries, along with the Department of the Environment, to see that something is done about the sewage from Market Square.

Bill Ayer: One thing I did not clarify is that I think the solution to the problems has to be at various levels of government; provincial, federal and municipal, including the citizenry. I think that people, including biologists, are guilty of doing experiments or field work, coming to conclusions and wondering why they cannot get their ideas across to

the managers and the people involved. Unless there is some process for these three levels to meet and work together, then I think you are going to be struggling all the time.

Leonard Wilson: There is at some point, regardless of the harbour or river, a point where there is so much pollution that it turns into one big septic tank. Do we, as people, want this to continue along through our life and let it get to that point, or is there something that should be done with it now? I think that something should be done immediately about it.

Dave Scarratt: I think Len has got a point. It seems in looking back over what we have heard yesterday we could perhaps begin to eliminate one or two potential problems or thoughts that people have suggested might be problems. It seems that if I read what Shankar Ray had to say we probably do not have much of a problem with heavy metals at the moment, but I am wondering about effluent quality and all the other discharges that go into the harbour. Some discharges are currently either regulated or under some form of consideration of a regulation (I am thinking of those from the oil refinery and the two pulp mills), and it seems to me that these are the ones on which we are beginning to get some form of a handle. However, we have got no knowledge really of what else is going into the harbour, except that we know that it is a lot, and that it covers a variety of domestic sources and industrial sources. Notwithstanding the fact that we can probably answer the questions of the effects of heavy metals on fish, and that we can perhaps answer the question of the effects of pulp mill effluents on fish and its relevance in this area, there is a whole range of other factors of which we have as yet no measure or knowledge. I would be curious to know if you gentlemen have any thoughts along those lines.

Art MacKay: In reference to Dave's comment, I agree with him totally. I think there is a chemical complex that we do not understand. We tend to monitor the things that we have techniques to monitor, but we apparently do

not have the capability of monitoring the interactions between various chemicals and the environment. Looking at the Bay of Fundy as a whole, these chemicals are there. The transport has been demonstrated to go into the Bay, as a whole. We know that DDT coming down the Saint John River, for example, became neatly fixed in the local mammal populations in the Bay of Fundy. I think all of these mechanisms are there; we do not understand them, but we do have to start looking at them.

Shankar Ray: In support of Mr. Wilson's argument for the treatment of sewage, I would give you an example related to the cleaning up of the Thames River. I think sewage cleanup is one of the most important parts of cleaning up a river. For the Thames, if you look at the dredge spoils in the area, there are extremely high metal levels, there are extremely high levels of PCB's, and everything you could imagine, but still we know that the fish population is coming back in the Thames. And one of the reasons for the fish coming back in the Thames is because they are not avoiding the river anymore because most of the sewage has been eliminated from the Thames River. And I think Mr. Wilson's point is very well taken.

Mike Dadswell: We did have sewage in the harbour surface water in the late 50's, early 60's.

Dave Scarratt: It seems to me what we are beginning to hear, though, is that, because of the peculiar nature of the Saint John Harbour, particularly the section of the Reversing Falls, you have there a sort of natural mechanism which is, to a considerable extent, protecting us from the excess of our own faults so to speak. And if we did not have the Reversing Falls, chances are the Saint John might well be in a situation something like the Thames. The question is how far should we push our luck on that one, or to what extent should we try to ease back from our reliance and dependence upon it?

Allan Fiander: I just wonder to what extent the federal cutback in funding for treatment facilities and the infrastructure associated with rectifying this problem has really been questioned, and what sort of arguments have been, or might be, made to attempt to perhaps counter the effects of the cutback. Now Saint John is not the only place I am sure, but this seems like a classic case where the source of funding for coping with a major potential problem is drying up or dried up.

Fred Meth: I was not here yesterday, so I may have missed something, but it seems to me that we may be starting to focus on an issue for which I have not heard any evidence. Is there actually a major municipal sewage problem in Saint John harbour? I just have not heard the evidence.

Leonard Wilson: If you are fishing in the river, I will tell you there is. I think it is a problem that we should not have to put up with, and there can be something done about it.

Peter Eaton: I wonder if the question of untreated sewage discharge is in the realm of public health, or if it is actually affecting the fishery? I have not seen any real hard evidence in this whole workshop on the direct effects of anything that is going into the harbour. I have not seen any good evidence to show serious impact on the environment of the harbour or the outer harbour. We have heard that ocean dumping wastes and heavy metals do not seem to be a problem. As Don Bezanson mentioned, the dumped material is only a small portion of the sediment load in the harbour. We have heard discussions of the pulp mill wastes and the contents of the pulp mill wastes, but we still have not heard any conclusive remarks, other than Art MacKay's observations, about the impoverishment of the species in the sediments of the harbour. We have not heard any evidence of actual decreases in the fish population resulting from any specific pollution.

Art MacKay: I think that is an extremely dangerous tack to take. There have been reductions, demonstrable reductions, in the fishery in the area.

Whether these reductions are critical depends on your point of view. If you are a fisherman, it may be critical. If you are me, it is not critical at all. In view of port development and the way it is going, barring economic circumstances, it will become, at some time, critical. Dave has made this point that we should act now while we can. Bill has referred to the problems with these increments getting harder and harder to handle. If we start saying we don't have a problem now, we will find ourselves with a critical situation that we have to reverse. As it stands now, we may be able to stave off a critical set of circumstances. I think, if we think we have not got a problem, we won't act on it. That is what scares me more than anything else.

Don Bezanson: I'd like to amplify Art's point a little by mentioning that we really don't have a good physical picture of what is happening in the harbour yet, despite the major effort that has gone into studying the harbour over the years (especially in the 1958 survey by H. Neu). The physical nature of the harbour is so complex and so violent that it would be very difficult to say for sure exactly what is happening to sewage from a given sewage outfall or what is happening to sewage concentrations in the harbour as a whole, except maybe to say that flushing rates are very high. Given that physical difficulty, I agree with Art, that we should probably consider the worst possible case and give real thought to exactly what is happening at sewage outfalls and do some good measurements of circulation in the harbour, some good measurements of BOD levels, etc., associated with outfalls. There is potential for a very minor change in an outfall configuration to have a major effect on the transport of sewage in the net circulation. There are so many factors to consider regarding the physics of the harbour, for example, many currents go very strongly in one direction.

David Thompson: I am a former fisherman, and future fisherman, and currently employed as a Community Service Worker by the Department of Fisheries and Oceans. I was not here yesterday, but I have been here this

morning, and I am very concerned because of what was said just now about there seeming to be no good evidence of an effect on the fishery. I feel that this workshop is getting pretty well along now, but it seems to me that it has not been much of a workshop if something has not been identified in some way or another, because there certainly has been a decline in the fishery. When you look at the numbers of people fishing, and at the amount and species of fish caught in the area around and to the west of Saint John Harbour, now and years ago, the difference is tremendous. There are areas now where lobsters are so scarce that people no longer fish. The area around Mahogany Island has been that way for several years, and the problem has gone as far as west of Musquash Harbour. There have been changes in the bottom. I recently talked to some fishermen, one ground fisherman who recently started trawling again after a lapse of a number of years, and he told me that the bottom where he used to fish ground fish with long-line trawl gear had completely changed. He said where he used to bring up certain things on the trawl, now all he brought up was nothing, or a few star fish, or a little bit of mud. In other cases lobster fishermen have said, "Well, you know all we can get are traps full of very slimy, oozy, gooey mud, and no lobster, where formerly the bottom was very hard, and it used to be some of the best lobster fishing ground around." We can look at a situation, maybe in the early or late 1950's and up to the mid 1960's, when the village of Lorneville had 25 or 30 boats fishing out of that particular community, where now if you looked at the situation there might be 3 or 4.

Peter Eaton: I did not mean, in my comments, to infer that there has not been a reduction of fisheries. I think that has been pretty obvious.

Bev Bacon: We have just probably scratched the surface on some of the pollutants, but I would not want the regulators to sit back and wait till we scientists concluded everything right down to the last "i" dotted and "t" crossed. I would hope that the regulators, in the meantime, would be aware that there probably is a problem. Lets continue to define the

problem a little bit more closely, so that we have an ongoing process of trying to discover the effects of some of these things. We should not be sitting back waiting until all studies are concluded before any action is taken. I think we have to have a dual approach to the problem.

Mike Dadswell: I would like to make a comment. This comes from going to meetings like this a number of times, where two different groups of people really are arguing different sides of the same argument. When we look at scientific data, you have to always look at it from the perspective of being able to stand behind the interpretation. However, when you are a fisherman, the point of impact makes a large impression in your life. I think that these discussions start off much too broadly and do not focus on enough specifics, right now I would like to focus on some specifics. First, you are looking at two different kinds of fisheries. You are looking at a fishery that is going on in the river in a big way, because it is concentrated. This fishery really has nothing to do with the harbour in any form, but only affects the animal population itself. Yet, problems like sewage in the harbour affect the fishermen by making it a little harder to fish. In many cases these problems do not really bother the fish. Second, when we look at a fishery like that on lobster, which is a ground fishery dependent upon a specific habitat, we are dealing with a completely different problem. We should really stop worrying about fish populations going up in the river and the direct effects of the harbour on them. We should concentrate on the aspect of continual degradation of a habitat, bit by bit, by increments, over long periods of time. We should see the effect coming, so that people do not start screaming about it when it is usually too late. We are dealing with those two kinds of problems.

One of the reasons why Lorneville has a low fishery right now is because the salmon drift net fishery is closed down. The total number of fishermen could increase again if the salmon fishery was re-established. However, the number of lobster fishermen in Lorneville is down, and that number will probably not increase unless you stop incremental development

and arrest things like sedimentation. On a long term basis, maybe what is being dumped in the harbour has very little impact in the general sedimentation cycle, but the fact remains that it might be dumped during the month of July and August, when the water levels are usually low and the water is quite clear. Possibly the fishermen are not used to seeing all of this sediment out there, but all of a sudden it is there. So, if we are going to keep talking, it would be better to try to focus on specifics.

Art MacKay: Mike is saying exactly, better than I could, what I would have liked to have said. He is talking about sedimentation in lobster and I think there is another point to it. You are talking about direct observation and good, old-fashioned common sense. We should not have to prove everything in a scientific document before we act on the obvious. With regard to rivers, it is quite common to see a sort of subtidal delta effect off the mouth of the river. Based on the feedback that we have been getting from the fishermen, and our own observations, sedimentation is significant except in the inshore area. We are also getting the information from fishermen who are looking for groundfish, that they are being driven out of certain areas at certain times of the year. So, it looks as if you have some kind of back eddy that seems to affect the mouth of the Musquash. Then you have some sort of slowly, but ever enlarging delta of fine, silty mud. Something is happening in this, and this has come clearly to us. It is not a scientific piece of work; it is bits and pieces of information from a variety of fishermen's direct observations, and it appears that perhaps that is what is happening. We have to find out.

Dave Scarratt: The question then, surely, is to what extent is that deposition related to the types of development which we have seen in the harbour, such as the actual process of dredging and dumping. Possibly we can eliminate it if the amounts are insignificant relative to the amounts that are naturally in the system. In which case, then to what extent has the deposition been affected by change in currents out of the harbour or in the harbour mouth as a result of things like causeway construction?

Don Bezanson: Well, I think that sediment is transported from the dump site. It is conceivable that if sediment from that dump site moves over a sufficiently small area during a sufficiently short time, then the concentrations in the small area of impact could be large enough to show up, and to cause the kind of habitat changes that have been talked about here. However, it is very difficult to believe that a habitat can be destroyed by fine, oozy sediment moving through these very violent currents out into a regime where there is a tendency towards dispersion. It is possible, and is not completely ruled out by the sampling that we have done, which is in fact somewhat broader in terms of time scale and space scale than that which would be required to show these effects.

Changes in currents over a long period of time might do something of that nature over a broad area. It is hard to see port development causing a great deal off Lorneville. It is rank speculation, but I could see changes, say the Partridge Island breakwater and other small changes in the harbour, having an effect maybe up to Manawagonish, but it is hard to see it going any further. In terms of the broader, outer area of the harbour, the only factor that I can imagine having an effect at the moment is increased sediment load in the residual currents moving down that coast to the Bay of Fundy. That is the major source of sediment in that area.

Peter Eaton: Don, do you know of any data that looks at trends in sediment loading in the Bay of Fundy over the past 10-20 years? Has the Bay of Fundy become more heavily loaded with sediment?

Don Bezanson: The only way to approach that problem is to do a detailed study of land use along river basins, rates of coastal erosion, and so on.

Peter Eaton: There is no historical data?

Don Bezanson: There is no historical suspended sediment data that I am aware of.

Mike Dadswell: The way farming and forestry have gone on in the last 100 years has probably actually reduced the sediment levels.

Bill Ayer: That may be true. The only problem is that the type of forestry and farming has changed in methodology. Certainly with farming there is less acreage, but with forestry there is more open acreage now than at any other time because machines can harvest more in a shorter period of time.

Mike Dadswell: I just wonder if I can make one observation, and this is purely about a physical thing. As the mouth of the harbour has been compressed, what you are looking at is an increased velocity in the harbour area, probably which means that it takes a little longer for the sediment to come down once you get out into the bay. Perhaps as the mouth of the harbour constricts there is acceleration in one place and fallout in another place.

Art MacKay: I would like to amplify something on the basis of what Don said. I have been on a settling site in 100 feet of water and have seen those silts. I saw them with my own two eyes, and watched them roll into the water like flour. They do exist; I have seen them. Now if people do not want to believe that, that is fine. It is something that has happened, and I think we have to find out why it happened. Is it a contribution from the upper bay? It does not really matter. Something has happened, so we have to define it and act on it. I think that is the basic point that should come out of this whole workshop. Damm it, something is happening! We are in the process of developing a port and nobody, including the developers, wants to see the fishery go down the pipe with it. If we get at it now, it is conceivable that we can solve the problem.

Dave Thompson: I believe, like Art, that the problem can be solved, but we must have some kind of a firm management plan and timetable for cleanup around Saint John Harbour. I think we must also have a coastal zone

management plan for the Bay of Fundy that will designate zones as natural or coastal. This plan would be dedicated to the perpetuation of the fishery. Now what we have seen happen is a gradual decline in the fishery west of Saint John Harbour to Musquash. Where we have got as far as Musquash, many of the fishermen more eastward to Saint John, have been pushed down on the ground which was traditionally fished by other fishermen between Musquash and Point Lepreau. Thus, there may be more fishermen concentrated right there than there were in the past.

What I think the fishermen fear most is future development in Musquash Harbour. Art MacKay mentioned this morning that there is a perpetual problem in Courtenay Bay with dredging. If certain port development were to occur in Musquash Harbour, there would be a perpetual problem there with dredging too, and deposition of dredge spoils. I do not know, probably most people here are not familiar with Musquash Harbour, but to give a very short picture of it, it is a natural unspoiled zone. Musquash Harbour consists of hundreds of thousands of acres of tidal mud flats that would just wash down into any dredged out area. Now above these mud flats, there is probably the most extensive salt marsh food system in Saint John or Charlotte County. As well, it is a habitat for many forms of animals and birds. To see this area become industrialized would cause me concern.

Mike Dadswell: I think that is the point where we should start focusing and get specific about the bulk material. Maybe my talk this morning gave the impression that I did not think there would be too much effect on the fishery, but you see this trend for habitat destruction everywhere in the world. In the Maritimes we have the chance to hold it back and to keep our fisheries healthy, because really when it comes right down to it, those fish are going to be worth a lot of money as a renewable resource in a world filled with people. Musquash development could be a bulk terminal to bring in coal from the United States to feed Coleson Cove, and it could happen very quickly if the price of oil keeps going up, and they really decide they want to bring coal in badly. If they want to bring coal in,

lets keep it in one place. Let them bring it into Saint John Harbour then move it to Coleson Cove, but not develop another harbour two miles down the coast just because it saves them a few feet of railway.

Paul Mawhinney: I have been in the Saint John Harbour area as a Fishery Officer for 21 years. Prior to that I was a fisherman for 20 years, and I will add that, "If you can't beat them, join them." I have seen a lot take place in the last 21 years. We lost all our theaters in Saint John because they were forced out by the Chesley Street Thruway. The fishermen have no place to tie up their boats in Saint John so they moved to Five Fathom Hole, which I attribute to the lack of lobster fishing out along the Mahogany Island area. The gaspereau fishery, when they had the West Indian market, was a big fishery. But they lost that market and the catch went down because the effort went down. Now that there is a good market for pet food, in March and April, the gaspereau fishery has gone up again. That shows some of the fluctuations of gaspereau in Saint John Harbour. Not enough stress is put on the effort when these statistics were taken.

The shad fishery, this last 9 years, has been controlled, you might say, for the protection of salmon. There is nothing mentioned about that in our meeting here. To my mind there is the same amount of shad coming into the harbour and migrating up the river. The statistics would show that (if the shad were fished for a full season) but unfortunately the salmon is a very important fish, and a lot of stress is put on the protection of salmon. When there is a heavy run of salmon, we have to close the shad fishery too because too many salmon are taken on the by-catch. That has a lot to do with the statistics of shad.

I have hauled lobster traps with colleagues of mine in the Partridge Island area and the Mahogany Island area last fall. There are still lobsters there, but the people are not fishing there. Maybe it is because it does not pay them because they can go further west, but the lobsters are still there.

Owen Washburn: Although I sympathize with the view that Art has expressed, and the view that the fishermen have expressed from direct visual experience, I think it is very important that we do not abandon but step up the scientific effort to establish what is going on. I know that Art said, "Don't wait for that, we know there is something going on, let's go out and do something". The trouble with that is, that "the something we do" when we do not know what is going on, is to restrict everything because we have not identified the problem or its cause. I think that strategy is inherently weak. It seems to me that there has been some significant work recorded here. It may show negative results, but if there is a sediment buildup off Lorneville, surely we can discover the mechanisms and quantify the buildup so that we can determine the value of various aspects of physical development. To come back to what Art said earlier, "Let's live with development". In order for people who make decisions and make policy in this area to be in a position where they can make choices, we are going to have to be far more specific. I just hope we continue to collect the kind of scientific data that helps us to answer the questions.

Art MacKay: That is an interesting comment and I understand what you are saying, but I think you have misinterpreted what I have said. I've got to say that this workshop has been generated by the diligent, qualitative efforts of one man more than any other, and that is Leonard Wilson. He has made his observations and concern for the fishing industry known to a variety of people in the scientific community. Leonard, if what I am saying is true, has generated this scientific work that we have seen here at this workshop - a qualitative observation has generated quantitative work, and I think that is exactly the way the thing has to progress. I think we have to respond in a scientific way to direct observations.

This sort of thing reminds me of when I was a kid and I had this beautiful little trout stream in back of the house. The Town came along and decided they wanted to build a dump on it. They built the dump and all of a sudden we had a stream with no fish in it. It was brown, dirty and stank. I went

to our local representative to complain about the loss of my private trout stream, and I said, "If they had not built the dump on the stream it would not have killed the fish," and he said "We can't prove that the dump killed those fish", and damn it that is the truth. That is the way it is. No one could even prove that the fish were there before because it was just a bunch of 13 year old kids who said, "Yeah, there was a bunch of trout there". Damn it, it could be critical enough. We should act on qualitative observations and apply good scientific principals and quantitative data to the problems.

Engineers, on one end, build things; biologists observe natural effects. Instead of us being at opposite ends, lets get together; lets apply our knowledge and our expertise, their knowledge and expertise, and come out with the net best solution. That is all I am saying, and I am saying that science is the key to it.

Don Bezanson: I believe that there is a resolution between the two points of view expressed by Art and Mr. Washburn. I believe that Mr. Washburn would suggest that one should discover the precise source of sedimentation in the Lorneville area, because that source might be an easy point to attack in the development scheme. Then perhaps sedimentation could be stopped without stopping all development. I think that is probably the only solution in this case. I do not think that a large scale study can define a particular problem like that, sufficiently well to say, "Yes or no." I think that has been shown to be the case with the data as it exists now.

Alan McIver: One of the things I think should be mentioned is that there is a difference between preservation and change, and this is something which comes in and out of our conversation. We talk about changes in the environment; some can occur naturally, and some are caused by man. There is also degradation of the environment which also can be caused naturally or by man.

One tends to think in terms of degradation as far as chemical pollution or something similar. In such cases we can be relatively sure that there is a man-made effect because we know X chemicals, X sewage, X this, and X that, are being thrown in. Therefore, we could define that in terms of degradation. There are other things which may be called "change" which may be natural. There may be a natural change in the entire Bay of Fundy. There may be natural changes that are caused, for example, by natural silt coming down the river system. There are also changes which may or may not be detrimental. For example, the construction of the causeway made changes in the flow pattern, and with those changes came significant differences in the changes of patterns of sedimentation.

The Panel has responded to a number of questions, from the floor, about these kinds of changes. Perhaps when we come to recommendations, we should be thinking in terms of mechanisms to help us understand the past and future changes to the harbour environment. For example, models are used extensively in the United States. The Army Corp of Engineers has models which extend across acres representing some of the key harbours in the United States. I suspect that we may lack some of these kinds of mechanisms to help us understand and predict changes because these changes are very complex. Only as we start putting these factors in, perhaps even to physically model them, can we understand and predict what changes will take place.

Shankar Ray's work has given us some assurance that some of the chemical degradations are not as highly significant as we thought perhaps two to three years ago. What we have to focus on are the mechanisms of change, and determine which ones are going to be beneficial, and which ones we have to live with. For example, a fisherman may lose the fishing ground at point "X" and gain it at point "Y" as a result of current flow changes. Some would argue, to use a remote example, that the construction of the Canso Causeway has caused changes. Some fishermen have benefited by that change, others have lost as flow patterns have changed.

Shankar Ray: Despite the attempt to demonstrate that there has been a degradation in the fisheries resources, I have not seen any hard evidence that the fishery has been affected. There are two sides to the story. One side has given scientific arguments, statistical facts, saying that there is a natural cycle in the fisheries, while the other side has given a very qualitative, very subjective interpretation of the whole thing. I would like to know whether or not there is a problem.

Art MacKay: I would have to say that the fault for the lack of hard data, which seems to be desired by a lot of people rather than qualitative observations, has to rest directly with Fisheries and Oceans, which is the lead agency responsible for collecting useful data for application to problems of this kind. To this end, there will be a report presented to Dave Scarratt on March 31, documenting environmental conditions in a qualitative way. This report will contain data which, like Mike Dadswell's data, has limitations imposed on it by the statistical gathering methods used historically. I can say absolutely that physically there has been exclusion in fishing sites, and it really has nothing to do with fishing areas being eliminated by chemicals or sedimentation. There has definitely been exclusion of fisheries habitat in Saint John Harbour. That is clear from 1761 to the present. There have been areas that were available to the fishery that have been excluded by construction. There has been an impact on the fishery.

Shankar Ray: One aspect I would like to mention relates to the historical fishery. I do not think we can ever return to the type of fishery carried out in the 1850's, because then there were few jobs available and the fishery was one of the few sources of employment.

Art MacKay: I would say that the statistical data for fish catches on the east coast is equally abysmal today as it was in 1850. I do not think that we are very sophisticated in analyzing the fish catches in relation to specific sites. So you tell me how we were going to assess the changes in

the fishery. I do not know the answer to that but I think that you have to use qualitative and available quantitative data to come up with a feel for the impact. I do not see any other way to do it.

Shankar Ray: No, my question is what are you going to discuss? Are you going to talk about the future of Saint John Harbour, or what has happened before, which is very subjective?

Art MacKay: No, it is all part of a total progression. It would be very myopic of us not to look backwards to learn how the circumstances of today relate to past events. I think the same approach always has to apply. It is a continuum. We are not unique. We always tend to feel that we are a little sharper than those before us because we have better tools and techniques. Our techniques are not going to look as prominent in another 50 or 100 years. We are not a distinct point in time. We are part of a continuum, and the impact of the fisheries in the past is progressive.

Alan McIver: Speaking as an environmentalist, I would say that one must recognize that the fishery, itself, is a natural stress upon a resource. One tends to think in terms of fishery versus development, whereas in fact fishery is a development, and I think that this is not being made abundantly clear in our discussions. If the resource was left alone, it would not be fished or preyed upon to the same level that it was even back in the 1890's and, even then, there was a very significant increase as West Indian markets were developed. A tremendous pressure was being placed upon, in some cases, virgin stocks. One has to think in terms of the effect of the fishermen upon the environment, as well as the effect of other industrial development.

Art MacKay: Undoubtedly there have been impacts. In terms of the Bay of Fundy they may not be critical. In terms of the east coast they are definitely not critical impacts. In terms of Musquash Harbour to the Reversing Falls maybe it is critical - maybe it is not; but, if you happen to live in Lorneville, it is starting to become critical in a local sense.

Alan McIver: At the time of your earlier maps, in which you showed fishing vessels lined up wall to wall in the Saint John Harbour, there was a decision by the fishermen to use Saint John Harbour and to second the environmental aspect of Saint John Harbour for development. It was actually a fisheries development, which preceded even the lumber development, which affected fiscal decision, and secondly development.

Art MacKay: The other thing you have got to remember, I grew up on the St. Croix River, and attitudes have changed tremendously from the time I was living on the St. Croix River in which I used to swim. The favorite expression for anyone that wondered about pollution was, "Hell, don't worry about it, it flushes twice a day. There is all that water out there. It is not going to be a problem." We know that is untrue, particularly in a very localized sense. I do not blame anybody for the way the Saint John Harbour is. It is a logical sequence of events, in terms of thought processes, physical development, and economic needs.

Alan McIver: Our responsibility now is to ensure that future development takes place with a minimum of detriment to the environment.

Andre d'Entremont: I was noticing that almost all the discussion is centered around loss of habitat. Wouldn't you say that tainting a fish catch would be just as much of a problem?

Peter Eaton: The movement of ships in and out of the harbour, and the effect of oil and potential for oils spills, has not really been addressed by this meeting. I do not know whether this is a problem in the Saint John Harbour. Is it one of the problems? It has not really been brought up as a problem.

David Thompson: I believe there were some 60 tons of sardines that were found to be tainted with oil after they were packed and canned. They were put under detention and, I guess, eventually destroyed. Now also, there is

a large area of productive shellfish ground that is completely closed due to fecal coliform problems. As well, there have been problems in the harbour with gaspereaux that have become contaminated as fishermen pulled their nets up through the water at night and did not see the oil on the water. One of the fishermen recently told me that he is concerned about herring, taken from the Saint John Harbour, that were impounded for some time in waters thought to be contaminated with sewage. There are tainting problems and problems affecting the quality of fish. There have been occasions in the past where fish have had to be destroyed chiefly because of oil.

Dave Scarratt: At the moment there is nothing in the fisheries regulations which stipulates when a fish shall be considered contaminated. Clearly the inspectors, if they see oil on water, identify the fish as being contaminated and will withhold them from sale or confiscate the catch. This has been done on a couple of occasions. On one occasion, at least, I know of a buyer who refused to buy fish which were, at least, under threat of contamination. The net in which they were held was contaminated, although subsequent analysis at our lab showed that there was no detectable oil within the fish. On the other hand, we have had fish which have been contaminated with oil which could be measured and detected in the product. Needless to say these fish never reached the market. Thus, so far, there is no question about the quality of the marketed fish being affected.

Peter Eaton: It seems the major problem as far as the fishery is concerned is the reduction in habitat and the reduction of certain stocks along the coast. These are problems that have been identified. The reasons for this reduction is the question that we are facing, and one that has a very difficult answer. We cannot seem to zero in on whether it is sewage waste from the city, or industrial effluents, or an actual encroachment of sediment from the onshore dredging. Perhaps it can be related to overfishing. It is one of the possibilities.

Art MacKay: I think it is a multifaceted thing. It is going to be very hard to pick one thing and say "this is it". I think it is a broad spectrum problem, and I think it has to be approached from that perspective. If we approach it from one idea, I think we may miss the boat.

Bev Bacon: It seems to me that probably a lot of us have been working somewhat in a vacuum on individual problems within the harbour area, and if nothing else comes out of this conference, I think we are all going to have a general awareness that there are other aspects to this very large complex problem. Perhaps that is more of a conclusion than an implication, but I think that it is certainly important to bear in mind.

Scott McKnight: I have certainly seen it in the case of the Miramichi estuary. We are seeing here a lot of small studies that have been carried on by different groups, and now it seems necessary for someone to draw a line, sit down and say, "Are we adequately answering the questions posed by the local people, the local fishermen, and are we covering all the bases that we should be covering?". Perhaps the studies are centered on just the outer and inner harbours of Saint John and should include part of the Lorneville Peninsula area. What is needed is a group to sit down and say "Are we really answering all the questions that should be answered?", then get out there and do a decent study.

Don Bezanson: To return for just a moment to Sandy Ray's earlier question of deciding at this point whether the hard data or the subjective data is to take precedent. I would suggest that neither is of sufficient quality at this point to be able to resolve the question, and both have problems. The hard data has the problem of not giving a sufficiently broad or sufficiently detailed description of the real environment out there. I would like to caution people not to expect too much in terms of hard data, because you cannot describe the entire environment in all its facets. It is just impossible; it is too big. It would be too expensive to do that. I think the most we can do at this point is to try to focus on some of the

more definable problems, study those in detail, and proceed outward from there until they cease to become problems. To expand the kind of work we have been doing in the past, both in extent and intensity, would be prohibitively expensive.

Scott McKnight: But Don, we do not know that. Maybe it is worth the expense!

Don Bezanson: I would suggest that you get much more for your money by looking at some of the smaller details first, then maybe finding you have got to go for a very broad scale study. The remaining questions concern Art's observations of excessive sedimentation in the Lorneville area, and Leonard's observations of sewage fouling of operations in the harbour.

Shankar Ray: We have already been into that. What are the other problems? We do not know whether the sedimentation problem has been going on for the last 10 or 100 years.

Art MacKay: I am sorry, but you are slurring Leonard Wilson. I have heard people do this over and over and over again, and it makes me madder than hell, damm it. The man has sat on top of that all his life, and when you say there are no observations of anything of this happening, that is not true. There are no observations published with columns of figures and stats on them in the journals somewhere. Leonard Wilson has been observing it, and that can be backed up by observations from other people. We all live here, and we are all after the same thing. We are all after a good place to live for everybody who is involved. I keep getting ticked off when I see Leonard stand up and say this is the way it is and this is the way it was, this is what has happened and damm it no one believes him because it is qualitative.

Peter Eaton: Has nobody been doing anything about it in terms of actually going out, taking a close look, and trying to quantify it?

Art MacKay: The only reason I am here talking is because we responded to some of the needs in Leonard's area. We went down and made some observations. There was no mandate to go down and do detailed counts per square meter, and all this sort of thing. That is what is available. You either act on it or not.

Shankar Ray: Art, I don't want you to misunderstand. I am an environmental scientist, and I want to identify the problem so that we can deal with it. I am not denying the fact that someone has observed the problem. All I really want to know is what can we do about it?

Art MacKay: Quantitatively, we can only start at this point in time, because we do not have quantitative data from before. But we do have to act on the qualitative information that we have for the moment. Now we are supposed to get scientific.

Audience: Just a comment actually. It seems to me that one of the key issues here is that industrial port development tends to go ahead anyway, despite hard biological data, and I think there is a point where we have got to say, "Sure, we need the scientific studies; they are very important; they are urgent, in fact." But what happens when these scientific studies are being done at the same time that port development continues? We are uncertain whether this development is good or not.

Art MacKay: Knowledge will always run behind development, so you are always analyzing past events.

Dave Wildish: I think the suggestion this morning regarding hydraulic models is a case in which that is not so. One can predict from the kind of hydraulic models that Mr. McIver talked about this morning, and I think that this meeting should make modelling a recommendation.

Mike Dadswell: And if one wants, one can go back to Hachey's Harbour in the 1930's. I think there is sufficient data there to be able, once a proper hydrological model is built, to use the data to go back in time.

Dave Wildish: I prefer an actual, built-to-scale model on which you can put some potential port developments, and simulate currents, tides, and other factors.

Don Bezanson: It is very difficult to simulate three dimensional currents in a physical hydraulic model. You might achieve some success with a numerical model doing that kind of thing. There are particular parts of these problems, the incremental part of the problems, that could be solved ahead of time by doing that kind of modelling, or more probably numerical modelling or biological modelling, or the combination of physical and biological modelling. I think the time to make a model comes during the planning of harbour facilities, when problems are sufficiently small. You catch them when they are just increments when, maybe, the scientific problems are also sufficiently small. They can be handled and you can change one increment at a time from being negative to positive.

Dave Scarratt: It seems that we are dealing with questions of interaction. We have been trying to look, for the last day and a half, at the questions of interaction between the fishing industry and environmental quality, the way in which the port and City of Saint John have developed, and perhaps are likely to develop. Art, I think has shown us how a community which initially depended upon fishing and local transport changed to one which is almost entirely, as far as water activities are concerned, focused on the import and export business. Fishing takes a secondary role. I wonder if this is a projection which will, in effect, go on to infinity, at which time the fishing industry will be eliminated, possibly as far west as Musquash.

Art MacKay: I would like to see the two industries co-exist in some form. I think it is entirely possible for this to happen.

Bill Ayer: It is a problem of resolving conflict. That is what we have been talking about since we came here - this resolving of conflict between uses. The planning process and policies that come out of the resolution are supposed to be designed in such a way that the end result is a social decision made by the community. Should the community decide to protect the fishery? If so, then that is going to influence all the following decisions.

Dave Wildish: I disagree with your tactics in this. It is true that we are trying to resolve a multiple-use resource conflict. You seem to be stuck on the idea that we have to involve the general public. The point is that the two main antagonists, if you like, are the port developers who have already got a plan 100 years ahead, versus the three levels of government, plus the general public. How can you arrange those two to talk if you are going to do it in an organized system?

Mike Dadswell: The Department of Fisheries and Oceans has a Fisheries Act, Section 31, about fish habitat, which gives the Fisheries Department, which is supposed to represent fishermen and the public in this sector, control over development in areas of fish habitat.

Dave Wildish: The water authority in the U.K. developed a system which seems to work very well, in which the water authority has jurisdiction over one large area. Any change in that area goes to the water authority to be assessed by experts in the field of port development, water use, and water re-use. Technical decisions are made, and options laid out, which may be then given to the public or to a more general political process. The thing is, if we involve the public in technical arguments, we have lost.

Don Bezanson: I agree with Dave in terms of the practical difficulties of an adversary system for deciding these kinds of questions. The only way to side-step the problem is for the authorities, who are actually making the decisions on the development, to do only what will be beneficial, not detrimental, to the local fishery. If they do that, then we can stop worrying about the adversary nature of the problem.

Alan McIver: I was thinking in terms also of the Tennessee Valley Water Authority, where you have one authority who has the responsibility to ensure the best use of that watershed. I think that we have to think in terms of the best use of our environment here for the benefit of the people that live here.

Bill Ayer: What is the best use?

Alan McIver: Well, that is something that will come out of a proper resolution.

Bill Ayer: How do you resolve that?

Alan McIver: By having an authority that can look at it instead of opposing factions, one which says, "We have the Fisheries Act, therefore, we have the control", a second which says, "We are the port authorities and we have got complete rights as to the development of this area", followed by a third waving the BNA Act.

Bill Ayer: How does one authority resolve this issue?

Alan McIver: It is not an easy process, but it works.

Bill Ayer: How?

Shankar Ray: All of England has been divided into 14 water authorities.

Bill Ayer: Do they take this to the public at any point?

Shankar Ray: The whole river basin is under one water authority, and every development in that area, whether it is municipal, county, or whatever, has to be approved by the water authorities.

Bill Ayer: Do they have a plan?

Shankar Ray: They have the legislative power as well. They can prevent you from doing anything under their authority.

Bill Ayer: And do they take this to the public?

Mike Dadswell: In cases of technical questions, most of those are not taken to the public, but large scale, very large, high image things are taken to the public.

Bill Ayer: Thus, there is a sorting of the smaller problems. But if there is a plan, then they can put the increments in an overall context.

Mike Dadswell: We are getting back to coastal zone management. For the Saint John River Basin Board, this seems to have disappeared.

Bill Ayer: Well, that is an interesting thing because that seemed to come down to the coast, but there is nothing from the coast out. There was, at least, a planning effort to the coast. If you look at planning in New Brunswick it typically goes to the coast and after that there is nothing, but there are resources out there that people are using. There has got to be some sort of an assessment of those overall things that are incorporated in a decision making process.

Jim Hayden: If you are going to have a plan, you have got to know what your effects are. What is the effect of adding 50 more metres of wharf?

Bill Ayer: If you have a plan, then you can at least get at the problems, and that target is what you research. As someone said before, if you go out and try to know everything about the environment, you are going to spend more money than you will ever have. You have got to target the research.

Jim Hayden: How can you make decisions when you do not know what the effects are going to be?

Mike Dadswell: When you come to a meeting like this and you get nothing but caught in the middle all the time, you begin to think that there should be people out getting specific answers, and if you are going to keep having meetings like this then this means you should have some kind of intercoastal zone management and say "All right, we have to do research on some aspect to find out that answer".

Audience: I am wondering at the same time, do we go around talking about moratoriums on things or do we tend to neglect that aspect?

Mike Dadswell: Well, it is awfully hard to set up moratoriums because politicians have other ideas. You have to have a coastal zone management group with a region of authority first that can counteract development.

Bill Ayer: But that process still has to link to a political process.

Mike Dadswell: I know, but at least once it is in there it is a forum to counteract.

Jim Hayden: How many dollars does Saint John add to the provincial economy each year?

Garnet Phinney: About \$147 million.

Owen Washburn: Something that Mike said that he may not have meant to say in that way, but it is very important if you are going to start thinking about a coastal zone management effort, that, it not be something to counteract port development. It has to incorporate the port development.

Dave Scarratt: I just want to pick up the last point about weighing the relative financial contributions which different sectors of the economy might make. This could be an extremely dangerous argument. Let me draw the example of the Pittston refinery issue. There, for a variety of environmental reasons, Eastport is not an appropriate site for an oil terminal but, it has been suggested to us by people who are opposed to it that we should, in fact, be looking at the economic worth of what it is we do - what it is that we stand for.

If you look at fisheries in the primary value for that seaward end of the Bay of Fundy, you get a primary value to the fishermen something in the order of \$50 million annually. If you multiply that out by the normal sorts of multipliers for fish processing, then perhaps you are looking at \$250 million or something of that order.

It became apparent at those hearings that the company was quite prepared to absorb a bill for having their boats waiting while the tides were right or until the fog went away. They were quite prepared to pay a penalty, an annual penalty of \$12 1/2 million a year, which is a fantastic amount of money in terms of what we would expect in fisheries. But, it is peanuts by comparison to the total value of the commodity that they would propose to carry, which at today's prices would be something in the region of \$3 1/2 billion a year. Now that particular industry will support a local economy of 250 jobs plus the local spinoff, against which they might be prepared to haul in the balance, something in the order of 7,000 jobs. You are dealing with different levels. Some are capital intensive, some are human resources intensive. I think we have to be very, very careful about the cost of one versus the benefit to the other. I think we have to look at it

very clearly in the total social picture. I think we have to decide whether we really want to allow the progressive loss of the fishing industry, or manage things in order that we can try to get the best of both worlds. You cannot maximize for more than one variable, but you can optimize.

SESSION V: Recommendations and Conclusions

Dave Scarratt - Session Chairman

Introduction

This session of the workshop attempts to differentiate between what we understand about the Saint John Harbour environs and what is not yet well understood. The task is to seek a methodology which can be used to strive for and to create the degree of knowledge needed. Throughout the workshop, there are many aspects of the harbour environs which were discussed. Some of the information is well known and understood. The fact that industry is capable of discharging large quantities of pollution is well known; however, on the other hand, industry has been persuaded to curtail that activity to an extent technically and economically feasible. Now comes the question as to whether or not that level of treatment is sufficient. To that end, one starts looking at the receiving environment for information which would support or reject the need for further reductions in effluent discharges.

At this point, the task becomes very difficult because the scientific information is scarce, making it an arduous task to interpret this information. At best, one can unveil areas of concern where caution is necessary, and ensure that further development activities are carefully scrutinized as to their impacts on such things as water quality, fish habitat, or oceanography. In the interim, scientific research should be directed to determine the cause and effect relationship.

As for the future development activities, there are mechanisms which are now commonly practiced to assess the environmental implications. Environmental impact assessments are now quite common and regulatory agencies are striving to put these review mechanisms in place for new projects. As well, there is growing interest in coastal zone planning as

an ongoing mechanism to ensure development activities are undertaken in a proper manner.

Only through a spirit of cooperation, and an understanding of the concerns by all involved, can resolutions be achieved.

Dave Scarratt: What I will try to do is to put things down in categories. The first category is devoted to those things that are fairly clear, that we know about, those pieces of evidence, pieces of information or interactions. The second category contains areas where we are not sure, either because we only know half of the picture or, at the moment, we do not have any picture at all. The third category would be the mechanisms of how we actually go about resolving these things, and, included within that would be this whole question of coastal zone planning, if you wish.

Unlike Britain and some other countries where there are organizations such as a water authority, we do not have any organization or level of government which has exclusive jurisdiction to take hold of all of these issues and questions and resolve them. It has to be done on the basis of negotiation and discussion.

I would be interested in having your thoughts and ideas on this, but I think before we do that I would like to introduce the two panelists, Bev Bacon, who is with the Research and Productivity Council, and Garnet Phinney, who is our Port Engineer.

Garnet Phinney: I listened with great interest to everything said here today, and I agree with a lot. I have two recommendations that I would like to make. Number one, someone should gather and catalogue the wealth of information up here. Number two, we should discover the sources of pollution, whether they be the sewers or the pulp mills, or something else. Lets put the priorities on things.

Yes, we are going to develop the harbour, that is the only way it is going to go. I could talk for three hours, I have no intention of doing it here, but, I would like to mention that you have got to think about what the port means to Saint John and the surrounding area. People talk about this ... a lot of people have talked about it here, and I am not sure that they just don't look at it in maps. I love these areas, and yet I am the Port Engineer. We are a Blue Collar City in Saint John, and we are not Halifax with that nice academic atmosphere. If the port closed in Halifax, I do not think it would mean a hell of a lot. If the port closes in Saint John, it would mean that we would just dry up and blow away. So, the port is going to be here, and it is related to all the industries.

Bev Bacon: I must admit that when I first came I wasn't really sure whether there was a problem, and if there was a problem, just what kind of a problem there was, and I would just like to get a strong vote on what people's feelings are. First of all, is there anybody here that thinks that there is not any problem, that everything is going along as it should and we should not be fussing about it? How many people feel that the problem is basically an anthropogenic one; one created by man, or is it just a natural problem? If we are talking about sedimentation, something like that, that it is a natural course of events and man has really had little effect on it, or is it a combination of the two?

I think that one thing I would like to see, is the closing of the gap between those people making observations and those people doing scientific work. I think I tried to point out earlier that we need to stop working as individuals in particular areas; have some kind of coordination and direction in the work that we are doing; have more communication amongst those people working in the area; and from that, at least, identify the problems if not really solve them all. I do not think that will ever happen, but I think on that information base it would be easier. For people who are planning, and that is another thing that obviously is lacking here, I hear it mentioned quite frequently that there does not seem

to be an overall plan or master plan, and I think that kind of thing is needed. I would hope we can focus on some of the burning issues and then turn towards defining the next stage following this kind of meeting.

DISCUSSION

Art MacKay: I think a statement should be made that the National Harbours Board controls the harbour. I think there is a little paranoia coming here. Some of the people have practical problems to solve, while most of the people sitting here today have no practical experience at all. I, and not just the National Harbours Board, have something to say about what happens to the Bay of Fundy. If you can put an impermeable membrane across your boundary line, the Bay is totally your jurisdiction. If you cannot, then it belongs to all of us; it is a resource, it belongs to us, the people. I think we should start realizing that we are not antagonists; we live in the area that has the same resource. I think it has to be optimized. I think we should proceed in that vein.

Dave Thompson: I think that many people fear an intrusion from the port of Saint John or the Saint John Harbour. They fear that all the effluents from it will influence not only the area around Saint John, but also areas without connection with the city. These areas have been traditional resource based areas, part of a very productive economy and way of life for certain families of people for many generations. That is why these areas were originally settled and, in many cases, families have depended on fishing in these communities for their livelihood for five, six, or seven generations. Many of the young fellows would like to continue in that way of life, and few draw social welfare or are crying for one kind of new polluting development or another. These people simply want to continue in the same self sufficient way of life as their predecessors. They will be able to do that if they have the proper environment and the proper management of resources.

Now the fishermen in the last couple of years have got together on many issues, and have taken a firm stand upon managing the resource from their perspective, and they have even asked for greater enforcement of efforts to curtail lobster poaching and that sort of thing. They have assumed a very responsible position, but one thing they are having difficulty in controlling, and maybe cannot control, is pollution pressure that threatens a resource that they are dependent on. I think that this lack of control is what a lot of people fear, particularly in the case of Musquash Harbour.

We are looking at an area that traditionally has not been a port area for part of the City, or a harbours area where there has been any industrial activity. We currently see a reduction in the biological production capacity of the area from Saint John as far west as Musquash. Any development in or around Musquash Harbour will probably affect the pristine and sensitive environment that exists there now. I would like to present a particular recommendation to the Panel, and that is, "That a moratorium be placed on any development at Musquash Harbour, and also that we request that no funds be committed for any development there until complete studies are done on all possible environmental consequences resulting from any kind of industrial or port development in that area".

Garnet Phinney: You don't really have to make a recommendation like that because we could not move on Musquash Harbour unless there was a complete environmental impact study done. We can't even do anything within our inner harbour unless we go through a complete matrix on the environmental aspect of it. One thing that I would like to say is that I think people are getting a little bit mixed up about port development and industrial development. They are not really the same thing. I suppose one follows the other, or vice versa. Port development as such (building a wharf or moving material over the wharf) really does not add greatly to any pollution. The industry that backs it up probably does.

Dave Thompson: In looking at Musquash Harbour, which we are concerned with in this instance, we are looking at negative effects from both. We are looking at dredging, if there is wharf development there; we are looking at possible oil spills in the area. As for the magnitude of the problem, I do not know, but I know it is going to happen if there is that kind of development. Now, if there is industrial shore based development, depending on the type of industries, we are going to get pollution from that as well. I think that the appropriate environmental studies must be done. Now it is alright to say that we have to have an environmental impact assessment, but in this particular instance what I am recommending is that a complete environmental study be done under the watchful eye or guidance of this particular group here. Often many people do not want environmental impact studies carried out solely on the prerogative of the proponent of the project. I would like to see the environmental study carried out under the guidance of a group such as this.

Dave Scarratt: I think what you are coming around to Dave is this whole question of coastal zone planning, which basically should identify, or make it possible to identify appropriate developments and the appropriate conditions for them.

Bev Bacon: I just wanted to try and find out what further technical studies people feel need to be embarked upon in order to have a better information base. In other words, where do people feel the gaps are?

Gary Westlake: I think I could make one small suggestion on that. Although the harbour is very dynamic and difficult to study, and it may be a number of years before we fully understand it, if we ever do, there are a number of areas that could be covered relatively easily. I am thinking in terms of identifying, perhaps through dye study, the areas where the effluents from industrial and municipal sources might end up. It should be quite a straightforward task to accomplish.

Dave Scarratt: You wouldn't like to add to that and actually ask for the characterization of those effluents as well?

Gary Westlake: Well that would, of course, be useful. We can get characterizations of the effluents quite easily. A number of the industries report to us on a regular basis. However, I don't think the fate of these discharges has been mentioned at this workshop.

Bill Ayer: Jim was saying about 5,000 pounds of oil per day was being released into the harbour.

Jim Hayden: As I said at the beginning, when the refinery first became operational it was discharging quite a bit of oil. When it was expanded, a good treatment system was added, and now very little oil is being discharged. Most of the oil lying around the harbour comes from spill situations. From the 5,000 pounds you would subtract the amount that is cleaned up.

Dave Wildish: Just a point of interest. I have studied the benthos and hydrography in the Musquash estuary. I had hoped, with data from the hydrographic study, to make a mixing model of the estuarine system. It is a handy, very small estuary quite suitable for modelling, except for one problem. At the head of tide, there is an electricity generating plant which uses all the watershed flow from the west and east Musquash River. The flow is regulated by the generating plant, which I think operates in peak time only, so there is a very uneven input of fresh water into the Musquash. In fact, it was impossible to model because the fresh water flows were so uneven. I also learned at that time that over a period of 10 to 15 years the City plans to catch all the water from the east and west Musquash Rivers for use by the City of Saint John. We need not blame the Port Engineer here, because there is already a plan to take the fresh water flow from that system away, and the transport of nutrients from the Musquash marshes will be stopped.

Dave Scarratt: The implication of which is, of course, that we need more people than simply the Harbours Board and the biologists on our area development committee, or whatever it is. Does anybody else have other ideas on areas either where we are convinced we know things, or we are yet uncertain?

Clarence Spencer: I'm not sure, now that you have made that last statement, whether this falls in there. I am just wondering if there is any value in putting some effort into the design of various wharf structures. Even if there is not, perhaps we can find a better way of putting our wharves out into the water, at the same time keeping them open underneath so that we do not always reduce or restrict current flow through a channel.

Garnet Phinney: Design of wharves depends on many things, two of which are the cost (which in turn depends on the type of foundation), and the type of vessel that is going to use the facility. Then, it boils down to a matter of economics, whether we use a gravity-closed face structure or an open-piling structure.

Clarence Spencer: In other harbours, some wharves are open-crib or wood pilings which have not restricted the kinds of cargo. Wharves in Halifax Harbour have been standing for many, many years, and it seems that all kinds of cargo come in and out of there, and yet the physical flow of water does not seem to be decreased. Unlike Halifax Harbour, Saint John Harbour is very narrow and restrictive, and this is obviously affecting sediment transportation up and down and into the harbour. It is also affecting the current pattern and circulation, and perhaps as has been implied here, either moving the fish habitat around or totally eliminating it. I think that the combination of a narrow river with solid crib-work or concrete structures probably contributes to some of these problems.

Garnet Phinney: One of the recommendations, even in the Neu Report, is to set up a higher bed velocity in the harbour, but that may prove a problem at the mouth of the harbour as well.

Bill Ayer: But Neu also suggested that if he did that, he would cut down on dredging, did he not?

Garnet Phinney: Yes. Of course he had grandiose schemes which sounded great, for example, cut a channel from South Bay across to Manawagonish Cove, and then that would flood the whole salt water marsh that we have down there as well.

Mike Dadswell: Apparently a conflict exists between lobsters and harbours. There is a lobster season coming up in a couple of months. If people want to do things right they should generate some hard data to go into the computers in Halifax where there is data on individualized lobster landings for certain areas. I think there is probably data for this area, for each fisherman, going back some three or four years at least. It seems particularly necessary to do a lobster study this year to delineate the grounds and get some information. When you have a Fishery Officer telling us that there are still lobsters at Mahogany Island, and someone else telling us there are no lobsters at Mahogany Island, we need to have that well documented. We need to be able to see an individual fisherman's catch and see whether or not it has dropped off drastically. If the catch has dropped off, is it because the lobsters have moved off the fishing grounds to somewhere else?

Dave Wildish: Would the Panel like to comment on the kinds of mechanisms or organizations which might be set up in the future?

Dave Scarratt: As it was suggested before, there is no one mechanism, no one authority, notwithstanding the fact that the National Harbours Board does have authority within the harbour. Nevertheless, the Minister of the

Department of Fisheries and Oceans could ask to see, and modify, or can deny any plans which may significantly affect the fish or fish habitat. There are obviously other people who have to be involved.

There is one thing that we have not decided and that is, "Who should be represented on the committees. Who would have the responsibility for sitting down on a regular basis and identifying those parts of the section of the coastline which perhaps could be permitted to develop in certain fashions, or which should be reserved either for social purposes or for one industry or for another industry?".

Obviously, it would seem to me, that most of the industries should be represented, and most of those different government organizations at three levels - federal, provincial and municipal. There are a number of such committees in place already, but none of them seems to go quite far enough. We have within this area the Saint John Regional Development Committee, which is generally designed to promote industrialization of the Saint John and Charlotte County areas. We have another little committee based in St. Andrews, which is called the Fundy Regional Development Coordination Committee, and that consists basically of fishermen, a few fisheries authorities, and the fishing industry, but it does not seem to have any input from the other sides of development. Now obviously those two sorts of groups should be coming together on a more regular basis. Now, under whose authority should they operate, I don't know? Maybe somebody can suggest something.

Garnet Phinney: I think maybe one thing we should do is to get people from other industries within the city, within the area that could have some input in things like this.

Dave Scarratt: I come back to a point that Dave Thompson made a moment ago when he referred to this body or this organization and suggested that it might have authority. At the moment, it doesn't have any authority. It

has the authority of a group of people who seemingly have a common interest which is an understanding of the current effects and future implications of development and industrialization in the Saint John region. It came because a number of people had been discussing this for a while, and it came, I think, perhaps as a specific offshoot of a general scientific discussion, that was held in the next building on this campus late last fall where we discussed questions on the Bay of Fundy as a whole. It was decided it is worthwhile focusing on Saint John to find out what we know, what we don't know, and where perhaps we should be going; but we do not have any authority other than that of a group of interested people who can either afford the time or have got employers who are sufficiently interested to afford them the time to come and attend. So, we do not have authority.

Marianne Janowiz: In relation to your last comment, you were talking about coastal zone planning. What is the first stage of this? How does this happen?

Dave Scarratt: I think we are in it, but I am not certain quite what the steps are. The steps are obviously that people who have got either common interests or different interests in a common resource should discuss those interests. Now how you get out of the interest stage and into the authority stage, I'm not certain; it requires steps, obviously, at a level different from that which we have here. I can perceive them coming, but I am not certain quite how. Maybe it is just wishful thinking on my part, and perhaps on the part of others, but possibly if there are messages which we can take back to our superiors, and industry can take back to their superiors, which other levels of government can consider, then maybe if there is a will, possibly there would be a way.

Bill Ayer: You mentioned the sort of multi-level difficulties where there are so many acts and so many regulatory bodies that are operating. I am not sure you ever have one authority that does everything, but it might

make some sense to have an advisory body that has some powers to look at objectives for a planning effort, to recommend to the various levels of government that do control the situation, various methods of controls that may be used to achieve the various objectives which you began with.

Alan McIver: I was just trying to think of agencies in the Maritimes that already involve coastal zone management or have had some interest in the past. The first one that comes to mind is MRMS in Amherst, who have had an interest in coastal zone planning. There is also Roger Beardmore with the Lands Directorate, which is part of Environment Canada, who is the coastal zone focal point for the Maritimes. There is also a National Coastal Zone Management Coordinator, Mike Parks, in Ottawa.

There are some people who have had, at various times, the interest of the coastal zone at heart. One of the problems in the past has been this difficulty of getting various interested but unassociated bodies together. Seven years ago there was an attempt to get something off the ground; although not successful, it did however address a limited range of the coastal zone to see what could be done as far as identifying concerns five miles inland, I think, and ten miles offshore. The Port Mouton study compared aerial surveying, using remote sensing techniques with ground truthing exercises tied in with it.

Perhaps a recommendation from this committee would be that Saint John Harbour, being an area of immediate concern, could be an experimental test area, a focal point at least, for a practical application of coastal zone planning in the Atlantic Region.

Garnet Phinney: Alan, I want to say one thing. Several references have been made here about what the National Harbours Board can and cannot do. Don't think that we are not legislated and that we don't have controls on us.

Alan McIver: The planning forum would probably give you more opportunity to express the development aspect, and to benefit from a greater input from environmental people in a much more free moving forum than has existed in the past. I think in your opening remarks you said that this could not have taken place 10 years ago. That shows already that there is a move towards the recognition of a need for this kind of environment/development discussion. Maybe what we are looking for is not necessarily a more formal, but a greater opportunity, for an interchange of concerns so that the protagonist approach does disappear. Whether we like it or not, there have been misunderstandings on the part of various sectors of the community as to what people could do. This exercise to me has been extremely beneficial. It has put before a number of us the opportunity to discuss it. Maybe to be sure that it does more than just get discussed, we need a somewhat formal structure that would reflect the ideas into the political forum.

Dave Wildish: It seems to me that whatever happens, whatever group occurs, it has to be able to resolve questions on a large scale (at least the size of the Bay of Fundy, and maybe its watershed) in order to accommodate the conflicting interest (i.e., the multiple use resource conflicts) that could potentially arise in that system. By that I mean that the fishermen and the port developers would each know which areas they could develop.

Bill Ayer: One of the problems you get into with coastal zone management is assigning the boundaries. I don't know how you do that, but it is going to be essential to the success or failure of the thing, I think.

Bev Bacon: We seem to get bogged down with trying to determine how you make the thing work, and as Bill said if you don't put some kind of limits on it you don't really know where to stop, and it makes it a very unwieldy kind of thing to get going. Perhaps taking a small area, such as the Saint John Harbour, as a model might be a way, at least to begin. The ramifications and all the things that are wrong with the model will become apparent as time goes on; but at least you will have a start.

Gary Westlake: I would like to ask Mr. Phinney whether he feels that the discussions themselves are an appropriate mechanism for incorporating environmental concerns into the decision making process?

Garnet Phinney: Very definitely. I have learned so much from this, and it does help us in our decision making. We have been dealing primarily with the inner harbour, but now we are getting more and more involved with what we call the outer harbour because now, as you probably know, the harbour has increased about 15 times to what it was, and this is only in recent years. We are still thinking in terms of the inner harbour, but now we have got to realize that all of this harbour, the outer harbour, comes within our jurisdiction.

Leonard Wilson: While you are on the subject of the harbours here, in the master plan for the Saint John Harbour, I do not see a dock for the use of the general public.

Garnet Phinney: We, as a Crown corporation, run a commercial harbour. We build docks to make money. There are other agencies that are available for monies to build a fishermen's wharf, or a general wharf such as those in our national harbours. That is one thing that has been left out, to date.

Dave Scarratt: Well, I think we are focusing back in on the suggestion that when it does come to things like harbour development, not necessarily enough people are having their two cents worth put into the pot.

Alan McIver: Does the Panel, or anyone, have ideas on how industry and other "contributors to the harbour", if I can put it that way, could be more involved in some of the kinds of discussions we have had today? Can anyone come up with any suggestions on mechanisms to ensure that you are more involved?

Jim McGrath: I think you have to ask yourself why is industry not here? Why is it that, even invited, they do not want to come? And we get back to this whole adversary thing that we inevitably get into; this biologist from one side, engineers on the other. Why is that? I think if industry had been here, as I have been here for the last two days, and listened to this material, I think they would have gone away as I will go away, encouraged that a lot of things that needed to be brought out have been brought out. I wonder what, in the face of change, the traditional industry thinks about adapting to that change in terms of things like aquaculture? Maybe we have to realize that we cannot have a traditional industry the way it was in 1930 and have the development of the port at the same time. I think these are some of the things that have come out in the last couple of days, and I think that if industry could be here, could hear these things and could participate in these things, that they would be encouraged.

Jim Reid: I have sat here for two days now and listened with great interest to the sediment problems in the Bay. I have heard all about fauna in the Bay, but apart from the matter of sewage being disposed of in the harbour of Saint John, and apart from some numbers about sediments coming down the river of Saint John, we have had damn little hard data on which I can chew on. We have heard a lot about measurements and we have talked about dredging in Courtenay Bay, but I don't think we have had a real good, hard scientific approach to this problem. We have spent the last hour or so talking about studies in the future, and not said very much about that either. We have not been very specific about what is happening to the Bay.

Jim McGrath: If this workshop has no other objective than to meet again, say a year from now, or at some other time, and somehow get industry to come into this situation and express their views, I think that would be a great achievement.

Clarence Spencer: I would like to suggest that perhaps one of the reasons why other industry representatives are absent is simply that they don't

have a problem. Everything is running well for them. I just think that perhaps everything is fine from their vantage point.

Jim McGrath: I'm not sure that is true. I think that industry is sensitive to these things. They have to face public pressure; they have to face the pressure of the press. I think they feel it. We certainly feel it. I think though that it is a case of industry having to deal with a balance sheet versus "motherhood and apple pie". It is a no win situation for them; that is the way they feel about it at least.

Alan McIver: I think that Mr. McGrath made a very good point, that in the past, industry has been governed by public pressure, and biologists or environmentalists tend to have been governed by "apple pie". I think that if nothing else, this workshop has proved to me that those people here representative of development and industry, have been thinking not only of profits, but also the total cost to themselves and to the community in which they live.

Industry and society, as a whole, are looking at the environmental consequences of their actions without the environmentalist acting as the catalyst. They see it themselves because of the growth. I also see that the environmentalists that are present recognize that were it not for the industry much of the standard of living which they enjoy and the items which they use, which they almost take for granted sometimes, would not be there. Therefore, they recognize that the development and protection of your resource have to go hand in hand.

Owen Washburn: Somebody suggested a need for a more formal type of assemblage, and I think there is a lot of merit in that because I think it is easy for a meeting like this to load the dice against the guys coming from industry. You put yourself in their position. You are invited to a meeting by the policeman, the Environmental Protection Service, who is policing their activities, where they perceive a public airing of all the problems and a lot of fingers are going to be pointed.

I think, perhaps, the next level of discussion might be a smaller, more formalized but less generalized sort of discussion of the topic, and maybe where industry took part in organizing it. They might be approached as to how they would like to see some sort of a committee or some sort of a group organized, where representatives perhaps of the various agencies that are here, along with some representatives of the other interest in the harbour, might sit down and explore ways to go forward. They would be sitting down at a table with other people who have similar interest. I think that is one of the approaches.

Dave Scarratt: I think looking back over those three categories which I first suggested, that we have shown that there certainly are some aspects of the problem here. I think we have shown that there are some areas where we are ignorant. We certainly do have problems with our data base. Whether we can ever resolve these, I don't know, but clearly we have to address them. And certainly there are lots of suggestions for mechanisms by which we can come to resolve that.

SUMMARY OF RECOMMENDATIONS

The following recommendations were made by various participants which, although not formally voted upon, received general support.

A. General

1. Develop a Coastal Management Group(s) with authority to control the use (and abuse) of the coastal marine environment but which would also incorporate port development.
2. The need for coordination and direction must be met.
3. Failing the achievement of a governing body, an advisory body with some limited powers should be created.
4. Potential representatives for port and/or coastal development committees should be identified.

B. Saint John and Environs

1. A mechanism needs to be developed whereby industry can be involved in discussions similar to this workshop and in working committees in a non-adversarial manner.
2. A smaller, more formalized and more focused meeting should be held with industry participation to design an appropriate committee with authority to manage the development of Saint John and environs in an environmentally acceptable manner.
3. An environmental master plan to complement the existing development plan should be created. Comprehensive planning is needed for future harbour development.

4. An environmental impact study of Musquash Harbour should be carried out prior to any development in that area.
5. Existing information should be consolidated (this report will do much toward achieving this goal).
6. The sources of pollution should be identified and prioritized in order of significance.
7. The effluents into the harbour should be characterized.
8. Tracer dye studies should be carried out in Saint John Harbour to identify the areas where effluents from industry and municipal sources end up.
9. The configuration and location of sewage outfalls should be studied since minor changes could result in major effects due to the pronounced current patterns.
10. A physical or mathematical model of the current patterns within the harbour and environs should be developed. (D. Wildish hopes to develop a mixing model for Musquash Harbour.)
11. A thorough study of the circulation in the harbour and BOD levels should be carried out.
12. Wharf construction design needs to be investigated to determine the effect of closed versus open crib construction and make recommendations on future designs for open flow.
13. A lobster study should be carried out to delineate grounds and to obtain relevant information and catch statistics.

APPENDIX

List of Workshop Attendees.

W. Ayer	N.B. Environment, Fredericton, N.B.
B. Bacon	RPC, Fredericton, N.B.
D. Bezanson	Bedford Institute, Dartmouth, N.S.
I. Cameron	UNB, Saint John, N.B.
C. Campbell	City of Saint John, Saint John, N.B.
J. Conter	Martel, Halifax, N.S.
M. Dadswell	DFO, Saint Andrews, N.B.
M. DeGraeve	Montreal Engineering, Halifax, N.S.
G. DeLong	N.B. Environment, Fredericton, N.B.
A. d'Entremont	Dalhousie Ocean Studies Prog., Halifax, N.S.
C. Doiron	N.B. Power, Fredericton, N.B.
P. Eaton	EPS, Dartmouth, N.S.
A. Flander	ADI Limited, Fredericton, N.B.
P. Garland	Graduate Student, UNB, Saint John, N.B.
P. Gilbride	National Harbours Board, Saint John, N.B.
G. Gillis	Washburn & Gillis Assoc. Ltd., Fredericton, N.B.
W. Groom	N.B. Fisheries, Saint Stephen, N.B.
M. Harley	Atlantic Analytical Services, Saint John, N.B.
L. Harriott	Public Works Canada, Saint John, N.B.
V. Hawkins	EPS, Dartmouth, N.S.
J. Hayden	N.B. Environment, Fredericton, N.B.
L. Hildebrand	EPS, Dartmouth, N.S.
B. Hill	Marine Research Assoc., Saint Andrews, N.B.
M. Janowiz	St. Croix Courier, Halifax, N.S.
B. Johnson	CWS, Sackville, N.B.
J. Kellock-Heward	Times Globe, Saint John, N.B.
J. LeBlanc	Environment N.B., Fredericton, N.B.

APPENDIX (Continued)

G. Lindsay	EPS, Fredericton, N.B.
F. Lord	PWC, Saint John, N.B.
G. MacDonald	Graduate Student, UNB, Saint John, N.B.
D. MacGowan	National Harbours Board, Saint John, N.B.
S. MacKnight	PlanSearch, Dartmouth, N.S.
R. Manderson	DFO, Saint John, N.B.
P. Mawhinney	DFO, Saint John, N.B.
S. McCavoor	National Harbours Board, Saint John, N.B.
J. McGrath	N.B. Power, Fredericton, N.B.
A. McIver	EPS, Dartmouth, N.S.
F. Meth	MacLaren Plansearch Inc., Halifax, N.S.
K. Moreland	International Atlantic Salmon Foundation, Saint Andrews, N.B.
G. Phinney	National Harbours Board, Saint John, N.B.
S. Ray	DFO, Saint Andrews, N.B.
J. Reid	Atlantic Sugar, Saint John, N.B.
D. Scarratt	DFO, Saint Andrews, N.B.
C. Spencer	EPS, Dartmouth, N.S.
M. Thomas	UNB, Saint John, N.B.
D. Thompson	Fisheries Community Service, Saint John, N.B.
E. Vye	National Harbours Board, Saint John, N.B.
P. Wade	Conservation Council of N.B., Rothesay, N.B.
O. Washburn	Washburn and Gillis Assoc. Ltd., Fredericton, N.B.
R. Weir	UNB, Saint John, N.B.
G. Westlake	EPS, Dartmouth, N.S.
D. Wildish	DFO, Saint Andrews, N.B.
K. Wilson	N.B. Fisheries, Fredericton, N.B.
L. Wilson	Lorneville, N.B.
W. Wilson	AAS Ltd., Saint John, N.B.